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# An Evaluation of the Efficacy Of Gamma Globulin In the Prophylaxis Of Paralytic Poliomyelitis As Used in the United States 1953

*Report of the National Advisory Committee*
*For the Evaluation of Gamma Globulin*
*In the Prophylaxis of Poliomyelitis*



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*This study was sponsored by the Communicable Disease Center of the Public Health Service, in collaboration with the Association of State and Territorial Health Officers, the American Physical Therapy Association, and the D. T. Watson School of Physiatrics, which is affiliated with the University of Pittsburgh School of Medicine.*

*The report was approved and adopted by the National Advisory Committee for the Evaluation of Gamma Globulin in the Prophylaxis of Poliomyelitis at a meeting in Atlanta, Ga., January 27–29, 1954.*

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## In the Prophylaxis of Poliomyelitis

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[1] A temporary administrative unit within the epidemiology branch of the Communicable Disease Center, Public Health Service. A list of State health department officials, Public Health Service personnel, and physical therapists who participated in field activities of this program is given in appendix A.

[2] Dr. Lilienfeld, a consultant to the Communicable Disease Center, devoted his full time to the program until September 23, 1953, when he returned to Johns Hopkins University. He retained general supervision of the program after this date.

[3] Dr. Eichenwald was acting director of the program from September 23, 1953, until its termination.

# Contents

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*Personnel of the Administrative Service Section were:* Aubrey S. Burrowes, *Chief;* John R. Elton, *Chief, Machine Records Unit;* R. E. Shackelford, *Chief, Drafting Unit;* and W. L. Hunter, E. Feldman, and J. T. Hicks, *Draftsmen.*

# *Chapter I*

# Introduction

The announcement of the value of gamma globulin for the prophylaxis of poliomyelitis by Hammon and associates (*1–4*) in the fall of 1952, led to a major cooperative undertaking among multiple official and voluntary agencies to insure: (*a*) the availability of a maximum supply of gamma globulin by the summer of 1953; (*b*) an equitable and scientifically sound method of allocation throughout the Nation; and (*c*) a program of evaluation of its efficacy as actually used.

The problems of supply and distribution were met by effective teamwork among the Office of Defense Mobilization, and the Health Resources Advisory Committee, the Department of Defense, the National Research Council, the National Foundation for Infantile Paralysis, the American National Red Cross, the Association of State and Territorial Health Officers, and the Public Health Service. The success of this effort to procure and to ration gamma globulin is now a matter of common knowledge throughout the Nation.

During the discussions leading to the final plans for allocation and distribution of gamma globulin, it became acutely apparent that the total scientific knowledge available regarding it was exceedingly limited. Difficult problems confronted the several committees that were concerned with arriving at soundly conceived and administratively practical recommendations.

It was obviously desirable that a maximum effort should be made to study and evaluate the whole problem of gamma globulin in poliomyelitis during the first year of its general national availability. Such information would make possible sounder administrative decisions in future years and promote the best use of this limited and costly substance.

Accordingly, on April 22, 1953, the Communicable Disease Center of the Public Health Service in Atlanta, Ga., was directed to coordinate a national program and to appraise the results of gamma globulin inoculations during 1953. This Division of the Public Health Service, with its broad charter for conducting field research in the development and evaluation of new communicable disease control practices and its tradition of working in close cooperation with State health departments, was ideally suited to undertake such a program. This became a large-scale cooperative research undertaking. Although the program was conducted by the Communicable Disease Center, it was planned and guided by a National Advisory Committee of distinguished leaders in the field of poliomyelitis research. Full collaboration of 41 States and 4 large cities indicates the scope of the program. During the summer of 1953, about 235,000 children received inoculations of gamma globulin in cities and communities where there were outbreaks of poliomyelitis. Most of this gamma globulin was made available to the Nation by the National Foundation for Infantile Paralysis and the American National Red Cross.

The contribution of the profession of physical therapy to the program was crucial. An intensive training course in the principles of muscle evaluation was provided to the Communicable Disease Center epidemiologists by the faculty of the D. T. Watson School, Leetsdale, Pa. The American Physical Therapy Association, working directly with the States, arranged qualified physical therapy services to all participating areas. Those services were made possible through the aid of a grant from the National Foundation for Infantile Paralysis. As a result, the records of cases collected in this study have a greater accuracy, consistency, and validity than any that have been collected on such an extensive scale heretofore.

The present report summarizes the major findings of the study and the conclusions of the Advisory Committee.

# *Chapter II*

## Organization and Plan of the Study

From its inception, the program for the evaluation of the efficacy of gamma globulin in the prophylaxis of paralytic poliomyelitis as used in the United States during 1953, was visualized as an extensive group research project with national coordination but with execution by State and local health departments. The National Advisory Committee had been selected for the specific purpose of planning and guiding this type of program. While the members of this committee served as individuals most of them had participated in various capacities during the planning for allocation of the nationwide distribution. Similarly, all were planning activities either in the field, in the laboratory, or in the clinic in the study of poliomyelitis and the effects of gamma globulin during the summer of 1953.

The three State health officers, and five State epidemiologists on the committee served earlier in the year as official representatives of the Association of State and Territorial Health Officers in the development of the allocation plans. These representatives met in Atlanta in March 1953 and formally recommended that a national evaluation program be inaugurated. They offered to participate in the coordination of a national effort to obtain the maximum amount of consistent data. This action might well be taken as the inception of the program.

The Advisory Committee met in Atlanta on May 28, 29, and 30, 1953. In considering its mission the committee recognized that a practical objective was the collection of sufficient quantitative data to determine, if possible, the relative advantages and disadvantages of administration of gamma globulin to an entire age segment in an epidemic area and its use in household associates of cases of poliomyelitis. The committee considered the different viewpoints expressed during the winter and spring of 1953 in the committees and agencies which devised the allocation plan for apportioning the supply of gamma globulin between mass use and contact use.

The direct scientific evidence obtained during the field trials of 1951 and 1952 (1–4) suggested the value of mass use, at least when administered at a suitable time prior to expected illness in specified communities experiencing intense epidemics. It was clear, however, that the successful measurement of any mass effect, in terms of paralytic cases prevented or modified, would depend upon the degree of efficacy of gamma globulin, the intensity of the epidemic, and the time when inoculations were given in relation to the rise and fall of incidence of cases. There was some doubt whether the number of severe epidemics that would occur in the country would utilize effectively more than a small proportion of the anticipated supply. Furthermore, it was problematic whether the subsequent course of an epidemic in a threatened community could be predicted with sufficient accuracy and in sufficient time to permit the necessary community organization to inoculate the children at risk before the epidemic waned.

Answers to such questions could only be obtained from practical field experience. Therefore, one of the approaches considered for the evaluation program was to plan detailed epidemiologic descriptions of each of the epidemics in areas where there was mass use.

With regard to the alternate method of use of gamma globulin, namely, contact use, no direct scientific evidence based on field observations was available to support its value. However, because household associates have an increased risk of developing poliomyelitis, it seemed likely that the administration of gamma globulin to these associates would equal, if not exceed, the benefits of mass use in terms of cases prevented or modified. The basis for these estimates, however, rested strongly on the assumption that gamma globulin administered within 1 week of onset would modify the

severity of paralysis. This conclusion was reported by Hammon and associates (1–6), but the evidence was based on only 12 cases in his gamma globulin-inoculated group, compared with 16 cases in the gelatin-inoculated control group. Although the differences were statistically significant, conclusions based on such small numbers are hazardous in a disease as complex as poliomyelitis. There was a great need, therefore, to collect much more extensive data on the possible modifying effect of gamma globulin.

The committee recognized that it would be very difficult to conduct rigidly controlled studies in the United States during 1953. The committee recommended, therefore, that the effort be concentrated on the collection of a maximum amount of well defined descriptive epidemiologic data for careful analysis and comparison with the wealth of past epidemiologic experience in this country. It was believed that a marked preventive effect of gamma globulin in the recommended dosages when given at the right time might be observed in large epidemics, even in the absence of rigid controls, in the form of consistent and repeated deviations from classical epidemiologic patterns normally observed in the age group inoculated. If it had a marked modifying effect, this should be evident in the mildness of the paralysis among patients coming down with poliomyelitis after receiving gamma globulin. While recognizing certain difficulties in this plan of investigation, the committee, nevertheless, agreed that efforts should be made to collect the best possible data and to analyze them for valid conclusions.

Specifically, the committee recommended four approaches to the problem.

1. Descriptive epidemiologic studies for each of the areas where mass use of gamma globulin was employed.

2. A comparison of the severity of paralysis of patients developing the disease immediately before mass use with the severity of those acquiring the disease after receiving gamma globulin.

3. Study of the severity of paralysis among multiple-case households; namely, those households in which two or more cases of poliomyelitis were reported.

4. The documentation of administrative aspects of the distribution of gamma globulin.

The program followed the general plans and objectives recommended by the committee. In June an outline of the plans was sent to all State health officers, with an invitation that they join in the national undertaking. The response was immediate and gratifying. A total of 41 States enthusiastically offered to participate. Special arrangements were also made with Washington, D. C., and three other large cities—New York, Chicago, and Los Angeles. The population in the participating areas constituted about 90 percent of the country. Thus, the program was truly national in scope.

A National Gamma Globulin Evaluation Center with headquarters in Atlanta was organized as a special task force for the program. A group of 20 Epidemic Intelligence Service officers, 8 nurse epidemiologists, and 6 statisticians was assigned by the Communicable Disease Center for essentially full-time duty in the program.

## Mass Inoculation Areas

The descriptions of the epidemics in mass inoculation areas consisted of collecting for each case the date of onset, date of report (when obtainable); the verified diagnosis, paralytic and nonparalytic; the age, sex, and race; and whether or not gamma globulin had been administered. In 15 mass inoculation areas, an Epidemic Intelligence Service officer, a nurse epidemiologist, or a statistician, or a team, participated in the field investigations. More detailed data were obtained in some of those areas. Individual epidemiologic reports of 13 of these epidemics are presented in appendix B.

In the other areas, the data were generously submitted by State health officers for inclusion in the report. Thus, reasonably consistent descriptive data were obtained from each mass inoculation area.

In five of these areas (Macon County, Ill.; Steuben and Chemung Counties, N. Y.; and Caldwell and Catawba Counties, N. C.), the incidence of poliomyelitis after the gamma globulin administration was sufficiently great to


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warrant assigning physical therapists for special study of possible modification of paralysis.

## Multiple-Case Household Study

The study of multiple-case households constituted the most ambitious aspect of the program. In all participating States and cities, record systems for matching case reports were organized either at the local or the State level to identify multiple-case households. As soon as possible after the identification, field visits were made to the hospital, or home, to collect uniform data on all cases reported from these households. A standard form (appendix D) was provided. The main purpose of this visit was to verify the diagnosis and secure dates of onset that were as accurate as possible. A large number of different sources of data was used. These varied in their completeness and accuracy. Special effort was made, however, to determine the paralytic status of the patient during the period from 7 to 14 days after onset.

From 50 to 70 days after onset a muscle grading was performed on these cases by a physical therapist specially trained in a uniform method. A special abridged system of muscle grading was employed (appendix C). This system permitted an estimate of the extent of paralysis on the basis of muscle bulk involved. An index could be calculated and expressed in terms of percent of muscle damage. This 50- to 70-day standardized muscle evaluation became the basis of determining severity of paralysis in this study.

Upon completion of this 50- to 70-day examination, the records were forwarded to the National Evaluation Center in Atlanta for analysis. Multiple-case household data were accepted for the study if dates of onset fell within the interval from approximately June 1 to October 31. Records from 830 multiple case households comprising 1,828 reported cases of poliomyelitis were forwarded to the National Gamma Globulin Evaluation Center during the study.

## Administrative Aspects

Data on the administrative aspects of gamma globulin distribution were collected by statisticians and other Communicable Disease Center personnel assigned to the field. Observations were collected from 31 States.

*Chapter III*

# Poliomyelitis in the United States in 1953

Although in 1953 fewer cases of poliomyelitis were reported than in the record year 1952, it still ranks as the third most severe poliomyelitis year in numbers of cases reported, surpassed only by 1949 and 1952 (table 1).

Traditionally, the incidence of poliomyelitis in the United States reaches a peak in late August or early September. The epidemic curves for the Nation vary in different years from sharply peaked epidemics to broadly based ones. In 1953, the largest weekly number of cases was reported during the third week in August, but the epidemic had a broad base and more cases were recorded during September than in any other month. In table 2 the monthly incidence of reported cases of poliomyelitis is shown for the 5-year period 1949 to 1953. During the first 3 months of 1953, the monthly rates exceeded those of any of the previous 4 years. Those high rates presumably represent a continuation of the record epidemic of 1952. In April and May of 1953, however, the monthly rates also were higher than in previous years. It was felt by many epidemiologists that this high incidence might presage another record epidemic year, possibly even exceeding 1952. Of course, the importance of increased and possible over-reporting stimulated by the interest in gamma globulin needed consideration in the interpretation of the situation.

**Table 1. Reported cases of poliomyelitis and attack rates for the United States, 1944–53**

| Year | Number cases [1] | United States population [2] | Attack rate (per 100,000 population) |
|---|---|---|---|
| 1944 | 19, 029 | 132, 885, 000 | 14. 3 |
| 1945 | 13, 624 | 132, 481, 000 | 10. 3 |
| 1946 | 25, 698 | 140, 054, 000 | 18. 3 |
| 1947 | 10, 827 | 143, 446, 000 | 7. 5 |
| 1948 | 27, 726 | 146, 093, 000 | 19. 0 |
| 1949 | 42, 033 | 148, 665, 000 | 28. 3 |
| 1950 | 33, 300 | 151, 228, 000 | 22. 0 |
| 1951 | 28, 386 | 153, 383, 000 | 18. 5 |
| 1952 | 57, 879 | 155, 767, 000 | 37. 2 |
| 1953 | 35, 970 | 157, 956, 000 | 22. 8 |

[1] 1944–50 Vital Statistics Special Report, vol. 37, No. 9, June 15, 1953; 1951–52 Notifiable Diseases, Annual Summary; 1953—Cumulation, Weekly Morbidity-Mortality Report (preliminary data).

[2] Current Population Reports, Series P–25: 1944–49—No. 72, May 1953; 1950–52—No. 84, Nov. 1953; 1953—No. 83, Nov. 1953. United States total population as of June 1, 1953.

Beginning in June, the epidemic curve did not rise as rapidly as in previous years so that the rate for this month in 1953 was somewhat lower than the rate for 1949 and 1952. The whole epidemic curve in 1953 was more broadly based and peak incidence was considerably lower than that in 1949 and 1952.

As usual, the disease was widely disseminated. The accompanying map, showing the geographic distribution of the attack rates in 1953, reveals that no State was without the disease, and in fact, in 38 States, one or more counties experienced attack rates of 60 per 100,000 population or higher.[1] For comparison, a map showing the 1952 rates is also shown.

The northern part of the Nation appears to have been most intensely affected in 1953. There are clusters of contiguous epidemic counties in Illinois, Minnesota, Montana, Wisconsin, along the Ohio-West Virginia border, in New York, and in the mountains of North Carolina, Tennessee, and Virginia. Throughout the remainder of the United States the epidemic counties are more widely scattered, but no region escaped entirely this year. No large city experienced a serious epidemic.

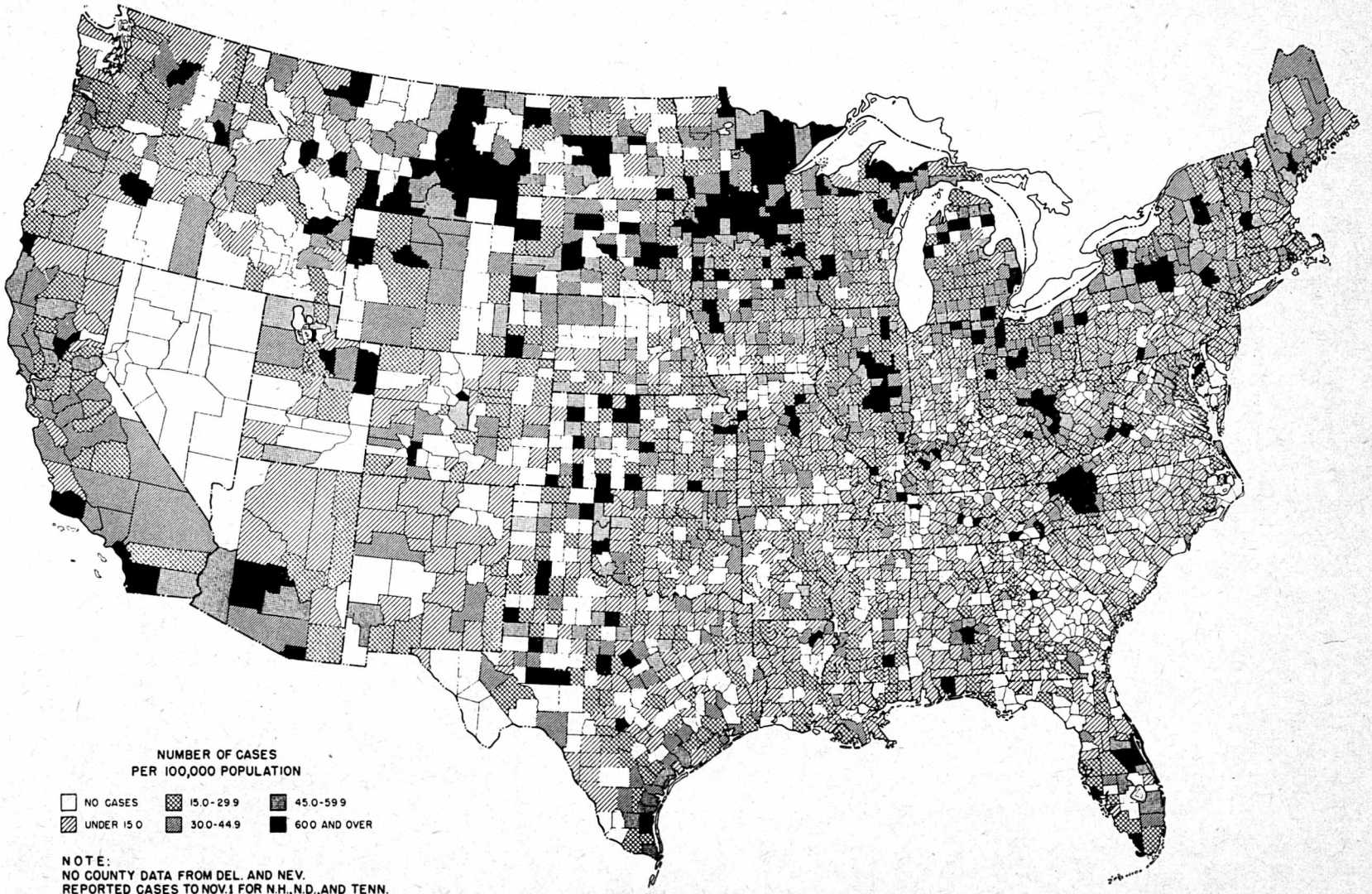
[1] No county data were available from Delaware and Nevada.

**Table 2. Reported cases of poliomyelitis and attack rates per 100,000 population, by months, for the United States, 1949–53**

| Month | 1949 | | 1950 | | 1951 | | 1952 | | 1953 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Cases | Rate | Cases | Rate | Cases | Rate | Cases | Rate | Cases | Rate |
| January | 486 | 3. 8 | 481 | 3. 7 | 650 | 5. 0 | 565 | 4. 3 | 791 | 5. 9 |
| February | 254 | 2. 2 | 397 | 3. 4 | 348 | 3. 0 | 382 | 3. 2 | 436 | 3. 6 |
| March | 253 | 2. 0 | 369 | 2. 9 | 232 | 1. 8 | 291 | 2. 2 | 290 | 2. 2 |
| April | 200 | 1. 6 | 257 | 2. 1 | 256 | 2. 0 | 313 | 2. 4 | 438 | 3. 4 |
| May | 415 | 3. 3 | 509 | 4. 0 | 351 | 2. 7 | 571 | 4. 3 | 616 | 4. 6 |
| June | 1, 539 | 12. 6 | 1, 136 | 9. 1 | 972 | 7. 7 | 1, 677 | 13. 1 | 1, 496 | 11. 5 |
| July | 5, 281 | 41. 8 | 3, 079 | 24. 0 | 3, 088 | 23. 7 | 6, 877 | 52. 0 | 5, 818 | 43. 4 |
| August | 14, 514 | 115. 0 | 7, 048 | 54. 9 | 7, 420 | 57. 0 | 15, 080 | 114. 0 | 8, 371 | 62. 4 |
| September | 9, 931 | 81. 3 | 8, 283 | 66. 6 | 6, 802 | 54. 0 | 16, 361 | 127. 8 | 9, 698 | 74. 7 |
| October | 5, 184 | 41. 1 | 6, 392 | 49. 7 | 4, 406 | 33. 8 | 10, 081 | 76. 2 | 4, 326 | 32. 2 |
| November | 2, 898 | 23. 7 | 3, 862 | 31. 1 | 2, 371 | 18. 8 | 3, 567 | 27. 9 | 2, 250 | 17. 3 |
| December | 1, 247 | 9. 9 | 1, 459 | 11. 4 | 1, 490 | 11. 4 | 1, 843 | 13. 9 | 1, 440 | 10. 7 |
| Total [1] | 42, 033 | 28. 3 | 33, 300 | 22. 0 | 28, 386 | 18. 5 | 57, 879 | 37. 2 | 35, 970 | 22. 8 |

[1] Figures for cases: 1949, from State Monthly Reports; 1950–52, Notifiable Diseases, Annual Summary; 1953 Cumulative Weekly Morbidity-Mortality Reports. Totals include cases not allocated by months.

Poliomyelitis in the United States, 1953. Cases per 100,000 population, by county, based on preliminary reports.



Distribution of poliomyelitis in the United States, 1952.

# Evaluation of Mass Use of Gamma Globulin

## A. Prevention of Paralysis

During 1953, gamma globulin was given by mass inoculation in 23 communities in the continental United States. A list of these communities, together with other pertinent information concerning them, is presented in table 3. Thirteen States are represented in this group. In all but two areas, entire county units were included. In one instance, mass use was limited to a city, and in another, only portions of two adjacent counties were selected.

The population size in these mass inoculation areas ranged from 6,800 to 139,000, with a majority falling in the 25,000 to 50,000 population group. The communities were selected in accordance with certain criteria promulgated by the Office of Defense Mobilization. The total number of children injected in these areas is close to 235,000.

As outlined previously, the plan of evaluation involved the study of the epidemics in mass inoculation areas to see if consistent deviations from classical epidemiologic patterns were discernible. Four general types of deviation were considered possible:

1. The presence of marked asymmetry in the epidemic curve beginning 1 week after mass inoculation.

2. A marked shift in the age distribution to older groups not receiving gamma globulin, this shift beginning after the mass administration.

**Table 3. Summary of data on gamma globulin mass inoculation areas, continental United States, 1953**

| County | Total population, 1950 census | Estimated population in age group receiving gamma globulin | Date certified for mass inoculation | Number of cases reported prior to certification | Attack rate per 100,000 population when certified | Age group injected and date | Number injected |
|---|---|---|---|---|---|---|---|
| Montgomery, Ala | 139, 000 | 30, 000 | June 26 | 71 | 51 | Under 10, June 30–July 3 | 32, 955 |
| Caldwell, N. C | 43, 350 | 12, 000 | July 2 | 74 | 172 | Under 10, July 6–8 | 12, 600 |
| Chemung, N. Y | 87, 000 | 17, 000 | July 7 | 50 | 28 | Under 10, July 11–13 | 37, 125 |
| Steuben, N. Y | 92, 000 | 18, 000 | | | | | |
| Catawba, N. C | 61, 800 | 14, 000 | July 10 | 37 | 60 | Under 10, July 15–16 | 14, 761 |
| Macon, Ill | 99, 000 | 19, 000 | July 13 | 14 | 14 | Under 10, July 17–18 | 21, 111 |
| Washington, Va | 37, 500 | 8, 500 | July 18 | 24 | 64 | 6 mo.–9 yr. (incl.), July 22–23. | [1] 9, 000 |
| City of Bristol, Va., and Tenn. | 33, 100 | 8, 000 | July 18 | 25 | 76 | 6 mo.–9 yr. (incl.), July 22–23. | [1] 8, 000 |
| Carter, Tenn | 42, 400 | 11, 000 | July 18 | 24 | 57 | 6 mo.–9 yr. (incl.), July 23–25. | 9, 200 |
| Marquette, Mich | 47, 654 | 9, 300 | July 18 | 17 | 36 | Under 10, July 22–23–24 | 9, 248 |
| Parts of McLean and Daviess, Ky. | [1] 6, 800 | [1] 2, 300 | July 21 | 9 | 132 | Under 15, July 25 | 2, 300 |
| Avery, N. C | 13, 350 | 3, 300 | Aug. 1 | 16 | 120 | Under 10, Aug. 6–7 | 3, 100 |
| Park, Mont | 12, 000 | 3, 170 | Aug. 21 | 10 | 83 | Under 15, Aug. 24–25–26 | 3, 526 |
| Smyth, Va | 30, 100 | 6, 840 | Aug. 20 | 36 | 119 | Under 10, Aug. 26–27 | 6, 546 |
| Custer, Mont | 12, 600 | 3, 500 | Aug. 29 | 13 | 103 | Under 15, Sept. 3–4–5 | 3, 440 |
| Stearns, Minn | 70, 700 | 21, 500 | Sept. 4 | 119 | 138 | Under 15, Sept. 9–11 | 26, 721 |
| Benton, Minn | 15, 900 | 5, 200 | Sept. 4 | | | Under 15, Sept. 11–14–15 | |
| Woodford, Ill | 21, 300 | 5, 800 | Sept. 9 | 18 | 85 | Under 15, Sept. 12 | 4, 699 |
| Polk, Wis | 25, 000 | 5, 200 | Sept. 11 | 18 | 72 | Under 15, Sept. 15–16–17 | 6, 702 |
| Meeker, Minn | 19, 000 | 5, 700 | Sept. 11 | 22 | 116 | Under 15, Sept. 16–18 | [1] 5, 000 |
| Randolph, Mo | 23, 000 | 5, 000 | Sept. 15 | 21 | 92 | Under 16, Sept. 17–19 | 5, 086 |
| Monroe, Fla | 30, 000 | 6, 750 | Sept. 28 | 34 | 113 | Under 15, Oct. 1–2 | 8, 550 |
| Shelby, Ill | 24, 400 | 6, 460 | Oct. 8 | 20 | 82 | Under 15, Oct. 14 | 4, 519 |

[1] Estimated.

SOURCE: Division of Civilian Health Requirements, Public Health Service.

3. A modification in the duration of epidemics based on past experience in the same or comparable areas and on the experience in other counties during 1953.

4. The presence of differences in the paralytic attack rates among children in the eligible age group according to whether or not gamma globulin had been given.

The epidemics in the 23 mass inoculation areas were examined for these types of deviation.

## Asymmetry in Epidemic Curves

Epidemic curves for each area are presented in figures 1–23.[2] They are arranged in the order of dates of mass inoculation. Two figures, A and B, are shown for each epidemic. The "A" figures present attack rates for total cases by date of report, and the paralytic and nonparalytic cases separately by date of onset. For the purpose of comparing the relative severity of epidemics, all the "A" figures have been charted to the same scale.

The "B" figures for each epidemic show the number of total cases and the paralytic cases in the age group eligible for mass inoculation and the total cases in the older age groups. The paralytic cases occurring after receiving gamma globulin are shown by asterisks in the appropriate figure.

According to the data of Hammon and associates, the preventive effect of gamma globulin begins about 1 week after its administration and persists at a significant level until about the fifth week. Since large-scale poliomyelitis epidemics tend to occur in symmetrical form, mass inoculations, if administered at or before the peaks of epidemics, might be expected to produce consistent and observable drops in the epidemic curve beginning about 1 week later. An asymmetry in the epidemic curve might become apparent, which should be most marked in the epidemic curve limited to the inoculated age group.

The recognition of such asymmetry is postulated on the assumptions (*a*) that the gamma globulin available in 1953 was effective, (*b*) that the mass administration was given at or before the peak of the epidemics, and (*c*) that the epidemics were of sufficiently large scale. If, however, mass inoculations were given using less potent gamma globulin, or when the epidemics were already rapidly diminishing, or in small-scale epidemics, then it would be difficult, if not impossible, to detect any effect attributable to gamma globulin.

In order to examine critically the epidemic curves in the mass inoculation areas, it was obviously necessary to limit the analysis only to those areas where gamma globulin had been administered prior to the end of the outbreak, and where, therefore, some observable effect might be expected. It was decided arbitrarily to examine only the epidemic curves from the communities where at least 6 cases occurred in the older, uninjected age group during the period beginning 1 week after the date of mass inoculation, and where at least 12 cases had occurred during the period prior to mass use in the younger age group that was to receive gamma globulin.

Using these criteria, 13 of the 23 epidemics were excluded, leaving 10 epidemics suitable for study of asymmetry. The epidemic curves for the age group receiving inoculations were examined and compared with similar curves from other epidemic counties where no mass inoculations had been given. A wide variety

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[2] Data for these charts were obtained as follows: Information was collected by the State health department, with the aid of a team from the Communicable Disease Center, in the counties of Montgomery, Ala.; Caldwell, Catawba, and Avery, N. C.; Washington and Smyth, Va.; Carter, Tenn.; parts of McLean and Daviess, Ky.; Randolph, Mo.; Stearns, Benton, and Meeker, Minn.; Monroe, Fla.; and in the cities of Bristol, Va. and Tenn. Information was supplied by State health departments for the following counties: Chemung and Steuben, N. Y.; Macon, Woodford, and Shelby, Ill.; Marquette, Mich.; Park and Custer, Mont.; and Polk, Wis.

Paralytic status was determined by a physical therapist 50 to 70 days after onset of poliomyelitis in the Counties of Montgomery, Ala., Caldwell and Catawba N. C., Chemung and Steuben, N. Y., and Macon, Ill. In the Counties of Washington and Smyth, Va., Carter, Tenn., parts of McLean and Daviess, Ky., Avery, N. C., and Randolph, Mo., and in the cities of Bristol, Va. and Tenn., paralytic status was based on hospital records and examinations made during early convalescence by physicians trained in muscle evaluation. In Stearns, Benton, and Meeker Counties, Minn., and in Monroe County, Fla., paralytic status was based on hospital records and on physical therapists' examinations made during early convalescence.

**Table 4. Age shift during poliomyelitis epidemics in mass inoculation areas [1]**

**I. Before and after mass inoculation**

| County and State by population size | Total population | Number of cases | | | | Percent of cases under 10 | |
|---|---|---|---|---|---|---|---|
| | | Before mass inoculation | | After mass inoculation | | Before mass inoculation | After mass inoculation |
| | | 0–9 | 10+ | 0–9 | 10+ | | |
| 50,000 or more: | | | | | | | |
| Montgomery, Ala | 139, 000 | 70 | 9 | 16 | 14 | 89 | 53 |
| Macon, Ill | 99, 000 | 18 | 12 | 21 | 24 | 60 | 47 |
| Steuben, N. Y | 92, 000 | 28 | 13 | 26 | 40 | 68 | 39 |
| Chemung, N. Y | 87, 000 | 32 | 9 | 17 | 9 | 78 | 65 |
| Stearns, Minn.[2] | 70, 700 | 90 | 24 | 13 | 8 | 79 | 62 |
| Catawba, N. C | 61, 800 | 46 | 10 | 15 | 22 | 82 | 41 |
| 25,000–50,000: | | | | | | | |
| Marquette, Mich | 47, 700 | 24 | 5 | 19 | 20 | 83 | 49 |
| Caldwell, N. C | 43, 350 | 79 | 13 | 32 | 18 | 86 | 64 |
| Carter, Tenn | 42, 400 | 21 | 3 | 1 | 0 | 88 | 100 |
| Washington, Va | 37, 500 | 20 | 9 | 9 | 13 | 69 | 41 |
| Bristol City, Va., and Tenn | 33, 100 | 24 | 2 | 11 | 13 | 92 | 46 |
| Smyth, Va | 30, 100 | 27 | 11 | 5 | 0 | 71 | 100 |
| Monroe, Fla.[2] | 30, 000 | 15 | 17 | 4 | 17 | 47 | 19 |
| 25,000 or less: | | | | | | | |
| Polk, Wis.[2] | 25, 000 | 18 | 7 | 0 | 0 | 72 | |
| Shelby, Ill.[2] | 24, 400 | 16 | 5 | 0 | 0 | 76 | |
| Randolph, Mo.[3] | 23, 000 | 18 | 6 | 1 | 0 | 75 | 100 |
| Woodford, Ill.[2] | 21, 300 | 9 | 12 | 0 | 0 | 43 | |
| Meeker, Minn.[2] | 19, 000 | 12 | 7 | 1 | 0 | 63 | 100 |
| Benton, Minn.[2] | 15, 900 | 13 | 6 | 2 | 0 | 68 | 100 |
| Custer, Mont.[2] | 12, 600 | 10 | 7 | 3 | 9 | 59 | 25 |
| Park, Mont.[2] | 12, 000 | 12 | 0 | 2 | 1 | 100 | 67 |
| Avery, N. C | 13, 350 | 7 | 5 | 4 | 2 | 58 | 67 |
| Parts of McLean and Daviess, Ky.[2] | 6, 800 | 8 | 2 | 1 | 0 | 80 | 100 |

[1] April 1–October 31, except for Polk, Carter, and Montgomery Counties where data are complete through August 31 only.

[2] Age groups are 0–14 and 15+ years because gamma globulin was administered through age 14 years.

[3] Age groups are 0–15 and 16+.

of asymmetrical epidemic curves was found, but the comparison with the curves in epidemic areas where no gamma globulin had been employed revealed no consistent differences.

In four of the mass inoculation areas (Macon, Ill., Caldwell, N. C., Catawba, N. C., and Montgomery Ala. Counties), the epidemic curve declined more steeply after the peak had been reached than it rose initially before the peak. This resulted in an asymmetrical curve skewed to the left which might, perhaps, be interpreted as indicative of a gamma globulin effect. This same type of epidemic curve, however, was observed in areas where no gamma globulin had been given.

In addition, in only one of these four areas, namely, Macon County, had gamma globulin been administered prior to the peak of the epidemic in the injected age group. In the other three counties, mass inoculations were given 1 week after the peak incidence had been reached. In Montgomery County, Ala., the abrupt decline in the number of cases of poliomyelitis preceded the date of gamma globulin administration by 1 week; only 2 cases occurred in the week in which the mass inoculations were given, while in the previous week 16 persons had become ill.

Since the epidemic curves appeared to vary greatly in form and symmetry, it was concluded that the observed asymmetries could not be attributed with assurance to gamma globulin effects and thus could not be utilized as measures of the preventive action of gamma

globulin in poliomyelitis, at least for the outbreaks studied in 1953.

## Shift in Age Distribution

If gamma globulin has a preventive effect, then the administration of this substance to a selected young age group might be expected to produce a decrease in the incidence of the disease in that group compared to the rest of the population. This might be manifested by a shift in age distribution of cases toward the older age group, beginning about 1 week after the date of mass inoculation, since at that time the number of cases in the group receiving gamma globulin should be diminishing rapidly.

The age distribution before and after community inoculation is shown for each mass inoculation area in table 4. It can be seen that in about 60 percent of these communities such an age shift took place.

In attempting to find a method of evaluating the age shift and comparing it to past experience, the problem of small numbers of patients involved was encountered. Two approaches were, therefore, chosen and since each one has its own advantages and disadvantages, both are presented. The first method consisted of dividing the duration of each epidemic of more than 25 cases into 3 periods of approximately equal length and then calculating the age distributions separately for each period. These data are shown in table 5. It can be seen that the number of cases in the first and last periods were usually small, and in order to allow for a more even distribution, each of these epidemics was also divided into three groups of patients of approximately equal size, and the age distribution again calculated (table 6). Tables 7–12 show similar data for other epidemics in 1953, where no mass inoculations were given, for epidemics in the mass use areas in previous years, and for epidemics in past years in various areas throughout the United States. This information is graphically presented in figures 24 and 25; the first shows the age shifts demonstrated by dividing the epidemic into thirds by

**Table 5. Age shift during poliomyelitis epidemics in mass inoculation areas (1953) [1]**

**II. Epidemic divided into 3 periods of approximately equal lengths**

| County and State by population size | Time of mass inoculation in relation to specific period | Number of cases | | | | | | Percent of cases under 10 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | First period | | Second period | | Third period | | First period | Second period | Third period |
| | | 0–9 | 10+ | 0–9 | 10+ | 0–9 | 10+ | | | |
| 50,000 or more: | | | | | | | | | | |
| Montgomery, Ala | Middle of second period | 24 | 4 | 54 | 10 | 8 | 9 | 85 | 84 | 47 |
| Macon, Ill | End of first period | 19 | 12 | 15 | 16 | 5 | 8 | 61 | 48 | 38 |
| Steuben, N. Y | Beginning of second period | 20 | 8 | 29 | 36 | 5 | 9 | 71 | 45 | 36 |
| Chemung, N. Y | Middle of second period | 27 | 4 | 13 | 11 | 9 | 3 | 87 | 54 | 75 |
| Stearns, Minn.[2] | Beginning of third period | 19 | 2 | 56 | 13 | 28 | 17 | 90 | 81 | 62 |
| Catawba, N. C | Beginning of second period | 41 | 11 | 18 | 18 | 2 | 3 | 79 | 50 | 40 |
| 25,000–50,000: | | | | | | | | | | |
| Marquette, Mich | End of first period | 24 | 5 | 15 | 17 | 4 | 3 | 83 | 47 | 57 |
| Caldwell, N. C | Middle of second period | 11 | 5 | 89 | 19 | 11 | 7 | 69 | 82 | 61 |
| Washington, Va | Beginning of second period | 15 | 9 | 8 | 9 | 6 | 4 | 63 | 47 | 60 |
| Bristol City, Va. and Tenn | Middle of second period | 9 | 1 | 21 | 6 | 5 | 8 | 90 | 78 | 38 |
| Smyth, Va | End of second period | 10 | 3 | 17 | 8 | 5 | 0 | 77 | 68 | 100 |
| Monroe, Fla.[2] | Beginning of third period | 4 | 7 | 10 | 10 | 5 | 17 | 36 | 50 | 23 |
| 25,000 or less: | | | | | | | | | | |
| Custer, Mont.[2] | Beginning of third period | 7 | 2 | 3 | 5 | 3 | 9 | 78 | 38 | 25 |

[1] Includes only outbreaks of more than 25 cases between April 1 and October 31. Data from Polk, Montgomery, and Carter Counties are complete only through August 31.

[2] Age groups are 0–14 and 15+ years because gamma globulin was administered through age 14 years.

**Table 6. Age shift during poliomyelitis epidemics in mass inoculation areas (1953)** [1]

**III. Epidemic divided into 3 groups of cases of approximately equal size**

| County and State by population size | Time of mass inoculation in relation to specific group | Number of cases | | | | | | Percent of cases under 10 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1st group | | 2d group | | 3d group | | First period | Second period | Third period |
| | | 0–9 | 10+ | 0–9 | 10+ | 0–9 | 10+ | | | |
| 50,000 or more: | | | | | | | | | | |
| Montgomery, Ala. | Beginning of third group | 33 | 4 | 36 | 3 | 17 | 16 | 89 | 92 | 52 |
| Macon, Ill. | Middle of second group | 12 | 10 | 17 | 8 | 11 | 17 | 55 | 68 | 39 |
| Steuben, N. Y. | Beginning of second group | 20 | 8 | 19 | 14 | 15 | 31 | 71 | 58 | 42 |
| Chemung, N. Y. | End of second group | 16 | 3 | 17 | 2 | 16 | 13 | 84 | 89 | 55 |
| Stearns, Minn.[2] | Beginning of third group | 42 | 5 | 33 | 10 | 27 | 18 | 89 | 77 | 60 |
| Catawba, N. C. | Beginning of second group | 21 | 5 | 20 | 6 | 20 | 21 | 81 | 77 | 49 |
| 25,000–50,000: | | | | | | | | | | |
| Marquette, Mich. | Beginning of second group | 17 | 4 | 15 | 11 | 8 | 13 | 81 | 58 | 38 |
| Caldwell, N. C. | Beginning of second group | 33 | 7 | 48 | 6 | 31 | 17 | 83 | 89 | 65 |
| Washington, Va. | Beginning of second group | 15 | 9 | 8 | 8 | 6 | 5 | 63 | 50 | 55 |
| Bristol City, Va. and Tenn. | Beginning of second group | 18 | 1 | 12 | 6 | 5 | 8 | 95 | 67 | 38 |
| Smyth, Va. | Middle of third group | 10 | 3 | 11 | 4 | 11 | 4 | 77 | 73 | 73 |
| Monroe, Fla.[2] | End of second group | 5 | 10 | 11 | 9 | 3 | 15 | 33 | 55 | 17 |
| 25,000 or less: | | | | | | | | | | |
| Custer, Mont.[2] | Beginning of third group | 7 | 2 | 3 | 5 | 3 | 9 | 78 | 38 | 25 |

[1] Includes only epidemics of more than 25 cases between April 1 and October 31. Polk, Montgomery, and Carter County data complete only through August 31.

[2] Age groups are 0–14 and 15+ years because gamma globulin was administered through age 14 years.

**Table 7. Age shift during poliomyelitis epidemics in areas not receiving mass inoculation (1953)** [1]

**I. Epidemic divided into 3 periods of approximately equal length**

| County and State by population size | Total population | Number of cases | | | | | | Percent of cases under 10 years | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | First period | | Second period | | Third period | | First period | Second period | Third period |
| | | 0–9 | 10+ | 0–9 | 10+ | 0–9 | 10+ | | | |
| 50,000 or more: | | | | | | | | | | |
| St. Clair, Mich. | 91,600 | 12 | 1 | 17 | 16 | 12 | 16 | 92 | 52 | 43 |
| Miami, Ohio | 61,300 | 12 | 13 | 7 | 9 | 5 | 1 | 48 | 44 | 83 |
| Wayne, Ohio | 58,700 | 4 | 7 | 3 | 4 | 4 | 5 | 36 | 43 | 44 |
| 25,000–50,000: | | | | | | | | | | |
| Dakota, Minn.[2] | 49,000 | 11 | 3 | 17 | 4 | 10 | 3 | 79 | 81 | 77 |
| Wilkes, N. C. | 45,200 | 11 | 2 | 18 | 4 | 13 | 8 | 85 | 82 | 62 |
| Hancock, Ohio | 44,300 | 9 | 1 | 3 | 5 | 4 | 6 | 90 | 38 | 40 |
| Barron, Wis.[2] | 34,700 | 6 | 1 | 12 | 4 | 7 | 5 | 86 | 75 | 58 |
| Washington, Minn.[2] | 34,500 | 11 | 2 | 10 | 7 | 5 | 3 | 85 | 59 | 63 |
| Less than 25,000: | | | | | | | | | | |
| Meigs, Ohio | 23,200 | 9 | 6 | 6 | 1 | 4 | 1 | 60 | 86 | 80 |
| Ashe, N. C. | 21,900 | 5 | 5 | 8 | 2 | 4 | 2 | 50 | 80 | 67 |
| Douglas, Minn.[2] | 21,300 | 8 | 6 | 11 | 2 | 2 | 2 | 57 | 85 | 50 |
| Watauga, N. C. | 18,300 | 7 | 6 | 7 | 4 | 6 | 1 | 54 | 64 | 86 |
| Schuyler, N. Y. | 14,200 | 4 | 1 | 7 | 5 | 2 | 7 | 80 | 58 | 22 |

[1] Includes only outbreaks of more than 25 cases between April 1 and October 31.

[2] Age groups are 0–14 and 15+ years to permit comparison with nearby mass inoculation areas.

cases, while the other shows age shifts demonstrated by dividing the epidemics into thirds by time.

The two figures for each area show essentially the same thing and are easier to visualize than the more detailed data presented in the tables. The mass inoculation areas in 1953 showed frequent shifts toward an older age group; a

**Table 8. Age shift during poliomyelitis epidemics in areas not receiving mass inoculation (1953)** [1]

**II. Epidemic divided into 3 groups of cases of approximately equal size**

| County and State by population size | Total population | Number of cases | | | | | | Percent of cases under 10 years | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | First group | | Second group | | Third group | | First group | Second group | Third group |
| | | 0–9 | 10+ | 0–9 | 10+ | 0–9 | 10+ | | | |
| 50,000 or more: | | | | | | | | | | |
| St. Clair, Mich. | 91,600 | 19 | 8 | 13 | 11 | 9 | 14 | 70 | 54 | 39 |
| Miami, Ohio | 61,300 | 8 | 9 | 7 | 10 | 9 | 4 | 47 | 41 | 69 |
| Wayne, Ohio | 58,700 | 3 | 7 | 5 | 4 | 3 | 5 | 30 | 56 | 38 |
| 25,000–50,000: | | | | | | | | | | |
| Dakota, Minn.[2] | 49,000 | 11 | 3 | 11 | 4 | 16 | 3 | 79 | 73 | 84 |
| Wilkes, N. C. | 45,000 | 14 | 2 | 13 | 4 | 15 | 8 | 88 | 76 | 65 |
| Hancock, Ohio | 44,300 | 9 | 1 | 3 | 5 | 4 | 6 | 90 | 38 | 40 |
| Barron, Wis.[2] | 34,700 | 11 | 3 | 8 | 4 | 6 | 3 | 79 | 67 | 67 |
| Washington, Minn.[2] | 34,500 | 11 | 2 | 10 | 7 | 5 | 3 | 85 | 59 | 63 |
| Less than 25,000: | | | | | | | | | | |
| Meigs, Ohio | 23,200 | 5 | 4 | 7 | 2 | 7 | 2 | 56 | 78 | 78 |
| Ashe, N. C. | 21,900 | 6 | 5 | 7 | 1 | 4 | 3 | 55 | 88 | 57 |
| Douglas, Minn.[2] | 21,300 | 5 | 3 | 7 | 3 | 9 | 4 | 63 | 70 | 69 |
| Watauga, N. C. | 18,300 | 6 | 5 | 7 | 4 | 7 | 2 | 55 | 64 | 78 |
| Schuyler, N. Y. | 14,200 | 7 | 2 | 4 | 4 | 2 | 7 | 78 | 50 | 22 |

[1] Includes only outbreaks of more than 25 cases between April 1 and October 31.
[2] Age groups are 0–14 and 15 years, to permit comparison with nearby mass inoculation areas.

**Table 9. Age shifts during previous outbreaks of poliomyelitis in mass inoculation areas (1944–52)**

**I. Epidemic divided into 3 groups of cases of approximately equal size**

| County and State by population size | Year | Total population (1950) | Rate per 100,000 population | Number of cases | | | | | | Percent of cases under 10 years | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | First group | | Second group | | Third group | | First group | Second group | Third group |
| | | | | 0–9 | 10+ | 0–9 | 10+ | 0–9 | 10+ | | | |
| 50,000 or more: | | | | | | | | | | | | |
| Montgomery, Ala. | 1949 | 139,000 | 39 | 12 | 6 | 14 | 7 | 14 | 1 | 67 | 67 | 93 |
| Macon, Ill. | 1952 | 99,000 | 64 | 16 | 9 | 12 | 10 | 10 | 6 | 64 | 55 | 63 |
| Steuben, N. Y. | 1944 | 92,000 | 305 | 54 | 60 | 40 | 53 | 28 | 46 | 47 | 43 | 38 |
| Chemung, N. Y. | 1944 | 87,000 | 259 | 52 | 32 | 39 | 46 | 22 | 34 | 62 | 46 | 39 |
| Stearns, Minn.[1] | 1952 | 70,700 | 78 | 9 | 15 | 7 | 8 | 6 | 10 | 38 | 47 | 38 |
| Catawba, N. C. | 1948 | 61,800 | 157 | 34 | 7 | 26 | 9 | 17 | 4 | 83 | 74 | 81 |
| 25,000–50,000: | | | | | | | | | | | | |
| Caldwell, N. C. | 1948 | 43,350 | 74 | 8 | 5 | 7 | 4 | 7 | 1 | 62 | 64 | 88 |

[1] Age groups are 0–14 and 15+.

**Table 10. Age shifts during previous outbreaks of poliomyelitis in mass inoculation areas (1944–52)**

**II. Epidemic divided into 3 periods of approximately equal length**

| County and State by population size | Year | Total population (1950) | Rate per 100,000 population | Number of cases | | | | | | Percent of cases under 10 years | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | First period | | Second period | | Third period | | First period | Second period | Third period |
| | | | | 0–9 | 10+ | 0–9 | 10+ | 0–9 | 10+ | | | |
| 50,000 or more: | | | | | | | | | | | | |
| Montgomery, Ala | 1949 | 139, 000 | 39 | 7 | 3 | 16 | 7 | 17 | 4 | 70 | 70 | 81 |
| Macon, Ill | 1952 | 99, 000 | 64 | 10 | 5 | 18 | 14 | 10 | 6 | 67 | 56 | 63 |
| Steuben, N. Y. | 1944 | 92, 000 | 305 | 54 | 60 | 46 | 58 | 22 | 41 | 47 | 44 | 35 |
| Chemung, N. Y | 1944 | 87, 000 | 259 | 52 | 32 | 51 | 59 | 10 | 21 | 62 | 46 | 32 |
| Stearns, Minn.[1] | 1952 | 70, 700 | 78 | 14 | 10 | 10 | 8 | 7 | 6 | 58 | 56 | 54 |
| Catawba, N. C | 1948 | 61, 800 | 157 | 24 | 3 | 44 | 8 | 9 | 9 | 89 | 85 | 50 |
| 25,000–50,000: | | | | | | | | | | | | |
| Caldwell, N. C | 1948 | 43, 350 | 74 | 6 | 2 | 8 | 5 | 8 | 3 | 75 | 62 | 73 |

[1] Age groups are 0–14 and 15+.

**Table 11. Age shifts during poliomyelitis outbreaks in various areas in previous years (1950–52)**

**I. Epidemic divided into 3 groups of cases of approximately equal size**

| County and State by population size | Year | Population | Attack rate per 100,000 population | Number of cases | | | | | | Percent of cases under 10 years | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | First group | | Second group | | Third group | | First period | Second period | Third period |
| | | | | 0–9 | 10+ | 0–9 | 10+ | 0–9 | 10+ | | | |
| Large population (100,000+): | | | | | | | | | | | | |
| New York City, N. Y | 1952 | 7, 900, 000 | 10 | 131 | 129 | 159 | 122 | 147 | 109 | 50 | 57 | 57 |
| Baltimore, Md | 1950 | 950, 000 | 32 | 72 | 20 | 70 | 40 | 68 | 33 | 78 | 64 | 67 |
| New Haven, Conn | 1951 | 545, 800 | 9 | 9 | 10 | 11 | 5 | 5 | 9 | 47 | 69 | 36 |
| New Haven, Conn | 1952 | 545, 800 | 8 | 8 | 5 | 7 | 6 | 9 | 9 | 62 | 54 | 50 |
| Hartford, Conn | 1952 | 540, 000 | 29 | 28 | 23 | 26 | 24 | 30 | 23 | 55 | 52 | 57 |
| Hartford, Conn | 1951 | 540, 000 | 20 | 17 | 17 | 8 | 26 | 15 | 25 | 50 | 24 | 38 |
| Fairfield, Conn | 1952 | 504, 300 | 18 | 16 | 18 | 12 | 18 | 13 | 15 | 47 | 40 | 46 |
| Pierce, Wash | 1950 | 275, 900 | 18 | 6 | 12 | 9 | 10 | 5 | 7 | 33 | 47 | 42 |
| Sedgwick, Kans | 1951 | 222, 300 | 108 | 46 | 33 | 54 | 22 | 54 | 30 | 58 | 71 | 64 |
| Winnebago, Ill | 1952 | 152, 400 | 39 | 10 | 7 | 11 | 8 | 10 | 14 | 59 | 58 | 42 |
| Moderate population (50,000–150,000): | | | | | | | | | | | | |
| Yakima, Wash | 1950 | 135, 000 | 134 | 23 | 44 | 28 | 37 | 19 | 30 | 34 | 43 | 39 |
| Snohomish, Wash | 1952 | 111, 600 | 35 | 7 | 9 | 10 | 7 | 2 | 4 | 44 | 59 | 33 |
| Snohomish, Wash | 1951 | 111, 600 | 32 | 6 | 6 | 5 | 9 | 6 | 4 | 50 | 36 | 60 |
| Champaign, Ill | 1952 | 106, 100 | 106 | 23 | 16 | 16 | 22 | 22 | 13 | 59 | 42 | 63 |
| Shawnee, Kans | 1952 | 105, 400 | 115 | 33 | 13 | 26 | 22 | 17 | 10 | 72 | 54 | 63 |
| Clark, Wash | 1950 | 85, 300 | 35 | 3 | 7 | 5 | 6 | 1 | 8 | 30 | 45 | 11 |
| Vermillion, Ill | 1952 | 85, 000 | 147 | 27 | 16 | 21 | 23 | 17 | 21 | 63 | 48 | 45 |
| Kitsap, Wash | 1950 | 75, 700 | 34 | 3 | 5 | 2 | 6 | 4 | 6 | 38 | 25 | 40 |
| Kitsap, Wash | 1952 | 75, 700 | 74 | 10 | 9 | 6 | 14 | 10 | 7 | 53 | 30 | 59 |
| Whatcom, Wash | 1952 | 66, 700 | 82 | 10 | 6 | 13 | 4 | 14 | 8 | 63 | 76 | 64 |
| Small population (less than 50,000): | | | | | | | | | | | | |
| Umatilla, Oreg | 1952 | 41, 700 | 130 | 17 | 6 | 4 | 15 | 8 | 4 | 74 | 21 | 67 |
| Coles, Ill | 1952 | 40, 300 | 387 | 27 | 21 | 29 | 41 | 15 | 23 | 56 | 41 | 39 |
| Chelan, Wash | 1952 | 39, 000 | 303 | 22 | 14 | 19 | 27 | 19 | 17 | 61 | 41 | 53 |

**Table 11. Age shifts during poliomyelitis outbreaks in various areas in previous years (1950–52)—Continued**

**I. Epidemic divided into 3 groups of cases of approximately equal size—Continued**

| County and State by population size | Year | Population | Attack rate per 100,000 population | Number of cases | | | | | | Percent of cases under 10 years | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | First group | | Second group | | Third group | | First period | Second period | Third period |
| | | | | 0–9 | 10+ | 0–9 | 10+ | 0–9 | 10+ | | | |
| Small population (less than 50,000—Continued | | | | | | | | | | | | |
| Okanogan, Wash | 1952 | 29, 100 | 124 | 4 | 7 | 5 | 9 | 2 | 9 | 36 | 36 | 18 |
| Malheur, Oreg | 1952 | 23, 200 | 224 | 9 | 9 | 9 | 6 | 11 | 8 | 50 | 60 | 58 |
| Wythe, Va | 1950 | 23, 000 | 796 | 54 | 23 | 45 | 27 | 26 | 8 | 70 | 63 | 76 |
| Meeker, Minn | 1952 | 19, 000 | 184 | 9 | 4 | 6 | 5 | 9 | 2 | 69 | 55 | 82 |
| Douglas, Wash | 1952 | 10, 800 | 315 | 5 | 4 | 4 | 8 | 6 | 7 | 56 | 33 | 46 |

**Table 12. Age shifts during poliomyelitis outbreaks in various areas in previous years (1950–52)**

**II. Epidemic divided into 3 periods of approximately equal length**

| County and State | Year | Population | Attack rate per 100,000 population | Number of cases | | | | | | Percent of cases under 10 years | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | First period | | Second period | | Third period | | First period | Second period | Third period |
| | | | | 0–9 | 10+ | 0–9 | 10+ | 0–9 | 10+ | | | |
| Large population (100,000+): | | | | | | | | | | | | |
| New York City, N. Y | 1952 | 7, 900, 000 | 10 | 6 | 7 | 173 | 159 | 258 | 194 | 46 | 52 | 57 |
| Baltimore, Md | 1950 | 950, 000 | 32 | 20 | 5 | 129 | 55 | 60 | 33 | 80 | 70 | 65 |
| New Haven, Conn | 1951 | 545, 800 | 9 | 5 | 8 | 17 | 8 | 3 | 8 | 38 | 68 | 27 |
| New Haven, Conn | 1952 | 545, 800 | 8 | 5 | 1 | 8 | 8 | 11 | 11 | 83 | 50 | 50 |
| Hartford, Conn | 1952 | 540, 000 | 29 | 23 | 13 | 46 | 42 | 15 | 15 | 64 | 52 | 50 |
| Hartford, Conn | 1951 | 540, 000 | 20 | 12 | 11 | 18 | 42 | 10 | 15 | 52 | 30 | 40 |
| Fairfield, Conn | 1952 | 504, 300 | 18 | 16 | 18 | 12 | 18 | 13 | 15 | 47 | 40 | 46 |
| Pierce, Wash | 1950 | 275, 900 | 18 | 5 | 7 | 8 | 13 | 7 | 9 | 42 | 38 | 44 |
| Sedgwick, Kans | 1951 | 222, 300 | 108 | 4 | 5 | 84 | 46 | 66 | 34 | 44 | 65 | 66 |
| Winnebago, Ill | 1952 | 152, 400 | 39 | 14 | 10 | 11 | 14 | 6 | 5 | 58 | 44 | 55 |
| Moderate population (50,000–150,000): | | | | | | | | | | | | |
| Yakima, Wash | 1950 | 135, 000 | 135 | 7 | 25 | 41 | 45 | 22 | 41 | 22 | 48 | 35 |
| Snohomish, Wash | 1952 | 111, 600 | 35 | 3 | 2 | 9 | 11 | 7 | 7 | 60 | 45 | 50 |
| Snohomish, Wash | 1951 | 111, 600 | 32 | 4 | 5 | 9 | 10 | 4 | 4 | 44 | 47 | 50 |
| Champaign, Ill | 1952 | 106, 100 | 106 | 11 | 11 | 28 | 27 | 22 | 13 | 50 | 51 | 63 |
| Shawnee, Kans | 1952 | 105, 400 | 115 | 7 | 2 | 42 | 26 | 27 | 17 | 78 | 62 | 61 |
| Clark, Wash | 1950 | 85, 300 | 35 | 2 | 6 | 5 | 7 | 2 | 8 | 25 | 42 | 20 |
| Vermillion, Ill | 1952 | 85, 000 | 147 | 5 | 8 | 29 | 13 | 30 | 39 | 38 | 69 | 43 |
| Kitsap, Wash | 1950 | 75, 700 | 34 | 2 | 5 | 4 | 7 | 3 | 5 | 29 | 36 | 38 |
| Kitsap, Wash | 1952 | 75, 700 | 74 | 9 | 6 | 11 | 20 | 6 | 4 | 60 | 35 | 60 |
| Whatcomb, Wash | 1952 | 66, 700 | 82 | 9 | 5 | 19 | 5 | 9 | 8 | 64 | 79 | 53 |
| Small population (less than 50,000): | | | | | | | | | | | | |
| Umatilla, Oreg | 1952 | 41, 700 | 130 | 20 | 9 | 5 | 16 | 4 | 0 | 69 | 24 | 100 |
| Coles, Ill | 1952 | 40, 300 | 387 | 11 | 5 | 44 | 57 | 16 | 23 | 69 | 44 | 41 |
| Chelan, Wash | 1952 | 39, 000 | 303 | 22 | 14 | 22 | 30 | 16 | 14 | 61 | 42 | 53 |
| Okanogan, Wash | 1952 | 29, 100 | 124 | 4 | 7 | 4 | 9 | 3 | 9 | 36 | 31 | 25 |
| Malheur, Oreg | 1952 | 23, 200 | 224 | 6 | 3 | 4 | 7 | 19 | 13 | 67 | 36 | 59 |
| Wythe, Va | 1950 | 23, 000 | 796 | 54 | 23 | 51 | 27 | 20 | 8 | 70 | 65 | 71 |
| Meeker, Minn | 1952 | 19, 000 | 184 | 7 | 1 | 8 | 8 | 9 | 2 | 88 | 50 | 82 |
| Douglas, Wash | 1950 | 10, 800 | 639 | 5 | 3 | 4 | 9 | 6 | 7 | 63 | 31 | 46 |

few counties, however, shifted toward a younger age group or remained unchanged. The charts of previous epidemics in mass inoculation areas and of other epidemics in 1953 indicate, however, that shifts in age distribution toward an older age occurred fairly commonly. This fact, together with the questionable validity of comparing trends evident this year in mass inoculation areas with those occurring in other epidemic areas in this and previous years, made this approach unsuitable; and, therefore, no definite conclusions could be drawn.

## Modification of Duration of Epidemic

Table 13 shows the duration of epidemics in the 10 to 90 percentile range in those mass inoculation areas where more than 25 cases occurred for both the age group receiving gamma globulin and for the general population. The duration of the outbreaks in the age groups receiving gamma globulin ranged from 6 to 13 weeks. Tables 14 and 15 show the duration of previous outbreaks in mass inoculation areas and in areas in which epidemics occurred during 1953, but in which no mass inoculations were given. It is apparent from these data that the duration of epidemics in these latter communities did not differ consistently from those found in mass inoculation areas. This fact is also shown graphically in figure 26. Here the duration of epidemics in mass inoculation and other areas is compared to the attack rate and population size. It can be seen that the attack rates in mass inoculation areas were generally higher than those in other areas, and that, within the limitations of the data, the durations of the outbreaks varied widely, with no apparent relation to attack rate, population size, or whether or not mass inoculations had been given.

## Comparison of Paralytic Attack Rates

Since it was not possible to achieve positive conclusions from consideration of the three foregoing methods of analysis, another approach was explored. Consideration was given to the possibility of comparing the paralytic rates before, during, and after the significant protection period described by Hammon and asso-

**Table 13. Duration of poliomyelitis epidemics in areas receiving mass inoculation (1953) [1]**

| County and State by population size | Total population | Population in 0–9 year age group | Number of cases | | Rate per 100,000 for total population | Rate per 100,000 for 0–9 year age group | Duration of epidemics (weeks) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | 0–9 years | 10+ years | | | 0–9 years | 10+ years | All ages |
| 50,000 or more: | | | | | | | | | |
| Montgomery, Ala | 139,000 | 29,424 | 86 | 23 | 78 | 292 | 11 | 12 | 11 |
| Macon, Ill | 99,000 | 18,753 | 39 | 36 | 76 | 208 | 7 | 10 | 10 |
| Steuben, N. Y | 92,000 | 18,325 | 54 | 53 | 116 | 295 | 11 | 10 | 10 |
| Chemung, N. Y | 87,000 | 16,218 | 49 | 18 | 77 | 302 | 13 | 9 | 11 |
| Stearns, Minn.[2] | 70,700 | 21,890 | 103 | 32 | 191 | 471 | 8 | 8 | 8 |
| Catawba, N. C | 61,800 | 14,108 | 61 | 32 | 151 | 432 | 6 | 5 | 5 |
| 25,000–50,000: | | | | | | | | | |
| Marquette, Mich | 47,700 | 9,300 | 43 | 25 | 143 | 462 | 9 | 9 | 9 |
| Caldwell, N. C | 43,350 | 10,774 | 111 | 31 | 328 | 1,030 | 7 | 13 | 9 |
| Washington, Va | 37,500 | 8,500 | 29 | 22 | 136 | 341 | 8 | 6 | 7 |
| Bristol City, Va., and Tenn | 33,100 | 8,000 | 35 | 15 | 151 | 438 | 7 | 6 | 9 |
| Smyth, Va | 30,100 | 6,840 | 32 | 11 | 143 | 468 | 7 | 6 | 6 |
| Monroe, Fla.[2] | 30,000 | 6,746 | 19 | 34 | 177 | 282 | 8 | 10 | 10 |
| 25,000 or less: | | | | | | | | | |
| Custer, Mont.[2] | 12,600 | 2,609 | 13 | 16 | 230 | 498 | 8 | 6 | 10 |

[1] Includes only outbreaks of more than 25 cases between April 1 and October 31. Data from Polk, Carter, and Montgomery Counties complete only through August 31. Duration measured by the interval in weeks between dates of onset of the 10 and 90 percentile of cases.

[2] Age groups are 0–14 and 15+.

**Table 14. Duration of previous epidemics in mass inoculation areas [1] (1944–52)**

| County and State by population size | Year | Total population | Number of cases | | Rate per 100,000 for total population | Rate per 100,000 for 0–9 age group | Duration of epidemic (weeks) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | 0–9 years | 10+ years | | | 0–9 years | 10+ years | All ages |
| 50,000 or more: | | | | | | | | | |
| Montgomery, Ala | 1949 | 139, 000 | 40 | 14 | 39 | 136 | 13 | 12 | 11 |
| Macon, Ill | 1952 | 99, 000 | 38 | 25 | 64 | 38 | 11 | 13 | 13 |
| Steuben, N. Y | 1944 | 92, 000 | 122 | 159 | 305 | 134 | 12 | 13 | 13 |
| Chemung, N. Y | 1944 | 87, 000 | 113 | 112 | 259 | 130 | 9 | 10 | 9 |
| Stearns, Minn.[2] | 1952 | 70, 700 | 31 | 24 | 78 | 44 | 6 | 17 | 11 |
| Catawba, N. C | 1948 | 61, 800 | 77 | 20 | 157 | 125 | 9 | 9 | 10 |
| 25,000–50,000: | | | | | | | | | |
| Caldwell, N. C | 1948 | 43, 350 | 22 | 10 | 74 | 51 | 7 | 7 | 7 |

[1] Includes only epidemics of more than 25 cases. Duration measured by the interval in weeks between dates of onset of the 10 and 90 percentile of cases.
[2] Age groups are 0–14 and 15+.

**Table 15. Duration of poliomyelitis epidemics in areas not receiving mass inoculation (1953) [1]**

| County and State by population size | Total population | Population in 0–9 year age group | Number of cases | | Rate per 100,000 for total population | Rate per 100,000 for 0–9 year age group | Duration of epidemics (weeks) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | 0–9 years | 10+ years | | | 0–9 years | 10+ years | All ages |
| 50,000 or more: | | | | | | | | | |
| St. Clair, Mich | 91, 600 | 19, 343 | 41 | 33 | 81 | 212 | 9 | 6 | 8 |
| Miami, Ohio | 61, 300 | 12, 452 | 24 | 23 | 77 | 193 | 10 | 8 | 10 |
| Wayne, Ohio | 58, 700 | 12, 168 | 11 | 16 | 46 | 90 | 10 | 9 | 9 |
| 25,000–50,000: | | | | | | | | | |
| Dakota, Minn.[2] | 49, 000 | 14, 890 | 38 | 10 | 98 | 255 | 13 | 10 | 12 |
| Wilkes, N. C | 45, 200 | 11, 206 | 42 | 14 | 124 | 375 | 11 | 10 | 10 |
| Hancock, Ohio | 44, 300 | 8, 596 | 16 | 12 | 63 | 186 | 7 | 7 | 10 |
| Barron, Wis.[2] | 34, 700 | 10, 382 | 25 | 10 | 101 | 241 | 9 | 8 | 10 |
| Washington, Minn.[2] | 34, 500 | 10, 307 | 26 | 12 | 110 | 252 | 8 | 8 | 8 |
| Less than 25,000: | | | | | | | | | |
| Meigs, Ohio | 23, 200 | 4, 796 | 19 | 8 | 116 | 396 | 8 | 8 | 8 |
| Ashe, N. C | 21, 900 | 5, 224 | 17 | 9 | 119 | 325 | 4 | 5 | 4 |
| Douglas, Minn.[2] | 21, 300 | 6, 087 | 21 | 10 | 146 | 345 | 7 | 10 | 10 |
| Watauga, N. C | 18, 300 | 4, 224 | 20 | 11 | 169 | 473 | 11 | 8 | 11 |
| Schuyler, N. Y | 14, 200 | 2, 910 | 13 | 13 | 183 | 447 | 13 | 5 | 6 |

[1] Includes only epidemics of more than 25 cases between April 1 and October 31. Duration measured by the interval in weeks between dates of onset of the 10 and 90 percentile of cases.
[2] Age groups are 0–14 and 15+ years to permit comparison with nearby mass inoculation areas.

ciates in the inoculated and uninoculated children. It was noteworthy that many paralytic cases appeared in uninoculated children, considering the relatively small number of such children thought to exist. It was necessary, however, to question the validity of this comparison because of the presumably disparate composition and unknown size of the two groups. It was conceivable that factors existed which would make the uninoculated groups a biased selection. It was, therefore, improper to apply this method of analysis to the experience in counties where mass injections were given.

## B. Modification of Severity of Paralysis

In five mass inoculation areas a sufficient number of cases of poliomyelitis developed after gamma globulin was administered to afford opportunity to study the possible modifying effect of gamma globulin on the severity of paralysis. In these counties all patients 0–9 years of age who become ill during the period beginning 1 week prior to mass inoculations and continuing for 31 days afterwards were examined by physical therapists. Essentially all these examinations were done 50–70 days after date of onset.

**Table 16. Number of cases in five counties by date of onset in relation to date of mass inoculation and gamma globulin status [1]**

| County | Group 1. No gamma globulin prior to onset | | | | Group 2. Gamma globulin prior to onset | | |
|---|---|---|---|---|---|---|---|
| | Onset in week prior to mass use | Onset on day of mass use | Onset after mass use | Total | 1–7 days before onset | 8–31 days before onset | Total |
| Caldwell, N. C. | 17 | 0 | 7 | 24 | 11 | 3 | 14 |
| Catawba, N. C. | 9 | 1 | 0 | 10 | 7 | 1 | 8 |
| Chemung, N. Y. | 3 | 2 | 1 | 6 | 2 | 1 | 3 |
| Macon, Ill. | 6 | 1 | 0 | 7 | 6 | 5 | 11 |
| Steuben, N. Y. | 8 | 4 | 3 | 15 | 6 | 6 | 12 |
| Total | 43 | 8 | 11 | 62 | 32 | 16 | 48 |

[1] Totals do not include cases in multiple case households, nor cases over 9 years of age. Also excluded are 5 cases in which gamma globulin was given at other times than in mass inoculation clinics, and 4 cases in which gamma globulin was given after onset.

**Table 17. Age distribution of cases in 5 counties by time of onset in relation to date of mass inoculation and gamma globulin status [1]**

| Age group | Group 1. No gamma globulin prior to onset | | | | Group 2. Gamma globulin prior to onset | | |
|---|---|---|---|---|---|---|---|
| | Onset in week prior to mass use | Onset on day of mass use | Onset after mass use | Total | 1–7 days before onset | 8–31 days before onset | Total |
| <1 | 2 | 0 | 2 | 4 | 3 | 0 | 3 |
| 1–4 | 29 | 4 | 5 | 38 | 17 | 6 | 23 |
| 5–9 | 12 | 4 | 4 | 20 | 12 | 10 | 22 |
| Total | 43 | 8 | 11 | 62 | 32 | 16 | 48 |

Chi-square test for age shift

| Age | Cases with onset in week prior to use | Cases with onset after mass use |
|---|---|---|
| 0–4 | 31 | 26 |
| 5–9 | 12 | 22 |

Corrected $X^2$ $X^2=2.40$ $P=0.13$

[1] Totals do not include cases in multiple case households, nor cases over 9 years of age. Also excluded are 5 cases in which gamma globulin was given at other times than in mass inoculation clinics, and 4 cases in which gamma globulin was given after onset. The counties are: Caldwell and Catawba, N. C.; Chemung and Steuben, N. Y., and Macon, Ill.

**Table 18. Distribution of muscle scores in five mass inoculation areas[1] among cases of poliomyelitis with onsets during specific periods before and after mass inoculation**

| Muscle scores (percent involvement) | Group 1. No gamma globulin prior to onset | | | | Group 2. Gamma gobulin prior to onset | | |
|---|---|---|---|---|---|---|---|
| | Onset in week prior to mass use | Onset on day of mass use | Onset after mass use | Total | 1–7 days before onset | 8–31 days before onset | Total |
| 0 | 6 | 1 | 0 | 7 | 7 | 1 | 8 |
| 0.1–0.49 | 0 | 0 | 2 | 2 | 0 | 1 | 1 |
| 0.5–4.9 | 15 | 3 | 4 | 22 | 11 | 9 | 20 |
| 5.0–9.9 | 8 | 1 | 2 | 11 | 4 | 2 | 6 |
| 10.0–14.9 | 4 | 0 | 2 | 6 | 3 | 0 | 3 |
| 15.0–24.9 | 4 | 2 | 0 | 6 | 3 | 3 | 6 |
| 25.0–34.9 | 2 | 0 | 0 | 2 | 3 | 0 | 3 |
| 35.0–44.9 | 2 | 0 | 0 | 2 | 0 | 0 | 0 |
| 45.0–54.9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 55.0–64.9 | 0 | 1 | 1 | 2 | 1 | 0 | 1 |
| 65.0–74.9 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 75.0+ | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| Total | 43 | 8 | 11 | 62 | 32 | 16 | 48 |
| Geometric mean (percent involvement) | 7. 37 | 7. 81 | 7. 36 | 7. 42 | 5. 71 | 3. 76 | 4. 91 |
| Percent of severe[2] cases | 32. 6 | 37. 5 | 27. 3 | 32. 3 | 31. 3 | 18. 8 | 27. 1 |

Analysis of variance table[3]

| Source of variation | d. f. | S. S. | M. S. | F |
|---|---|---|---|---|
| Between groups | 1 | . 722 | . 722 | 2. 80 |
| Within groups | 90 | 23. 191 | . 258 | |
| Total | 91 | 23. 913 | | |

F test significance:
F=2.80
P=0.10

[1] The counties are: Caldwell, N. C.; Catawba, N. C.; Chemung, N. Y.; Macon, Ill.; and Steuben, N. Y.
[2] Muscle scores of 10 percent or more.
[3] Based on cases having muscle scores of 0.5 percent or greater. Analysis of variance test for difference between geometric means of groups.

**Table 19. Distribution of paralytic and nonparalytic cases in five mass inoculation areas[1] with onsets during specific periods before and after mass inoculation**

| Status of paralysis | Group 1. No gamma globulin prior to onset | | | | Group 2. Gamma globulin prior to onset | | |
|---|---|---|---|---|---|---|---|
| | Onset in week prior to mass use | Onset on day of mass use | Onset after mass use | Total | 1–7 days before onset | 8–31 days before onset | Total |
| Paralytic cases[2] | 37 | 7 | 9 | 53 | 25 | 14 | 39 |
| Nonparalytic cases | 6 | 1 | 2 | 9 | 7 | 2 | 9 |
| Total | 43 | 8 | 11 | 62 | 32 | 16 | 48 |
| Percent nonparalytic | 14. 0 | 12. 5 | 18. 2 | 14. 5 | 21. 9 | 12. 5 | 18. 8 |

[1] The counties are: Caldwell, N. C.; Catawba, N. C.; Macon, Ill.; Steuben, N. Y.; and Chemung, N. Y.
[2] 0.49 percent involvement or below.

A total of 110 patients was included in this aspect of the study (table 16). These can be separated into those who did not receive gamma globulin (group 1, 62 cases) and those receiving it (group 2, 48 cases). Within group 1, 43 patients had onsets prior to the mass inoculation program and 19 came down at the time of, or following, the program. Within group 2, 32 patients received gamma globulin within 1 week of onset, and 16 patients received it from 8 to 31 days prior to onset.

The age distribution of these patients is shown in table 17. The cases occurring before mass inoculations were predominantly under 5 years of age, whereas after the program, a moderate shift of incidence to the 5- to 9-year group seemed to occur. Thus, the progressive shift in age composition of cases during an epidemic, shown previously for the group over 10 years of age, also appeared to operate within the under 10-year-age group in these counties. A Chi-square test, however, failed to show a significant difference in the age distribution of children before and after mass inoculation ($P=0.13$).

The severity of paralysis of the cases in these groups is presented in table 18. The distributions of muscle scores are roughly similar. Most of the cases were mild, approximately half of the cases having not more than 5.0 percent muscle involvement. Three simple measures were chosen to compare the relative severity of the groups: (*a*) the geometric mean of cases with muscle scores of 0.5 percent or greater; (*b*) the percent of cases with "severe" paralysis, defined arbitrarily as 10 percent or greater involvement; and (*c*) the percent of nonparalytic cases.

Using these three measures, the patients who received no gamma globulin, group 1, had a somewhat higher geometric mean muscle score, 7.42 percent, than the patients who were given gamma globulin, group 2, 4.91 percent. Similarly, there were 32.3 percent of "severe" cases in group 1 compared with 27.1 percent in group 2. As for nonparalytic cases, there were 14.5 percent in group 1 and 18.8 percent in group 2 (table 19). These differences all indicate that the severity of paralysis in the patients who did not receive gamma globulin was somewhat greater than that in the patients receiving it.

Such differences could be construed as either due to chance or to a slightly beneficial modifying effect of gamma globulin. An analysis of variance was performed on the data in table 18. This revealed that the difference between the geometric means of group 1 and group 2 was not significantly different ($P=0.10$).

Similarly, none of the other differences observed between the two groups or within the groups using any of the three measures of severity was significantly different. It must be concluded, therefore, that a modifying effect of gamma globulin had not been statistically demonstrated in the mass inoculation areas.

## Summary and Conclusions

The mass injection of gamma globulin carried out on a large scale in 1953 in the United States as a method to prevent paralysis in poliomyelitis infection was done as a public health measure in response to a widespread demand and not on an experimental basis. As such, attempts to draw conclusions regarding its efficacy have not been easy, and in many instances, have been impossible. In any event, the methods of analysis of carefully compiled and extensive data on the use of gamma globulin in these epidemic areas and populations, where it might have been expected to be effective, did not yield statistically measurable results. Therefore, its preventive effect in community prophylaxis as practiced during 1953 has not been demonstrated. Also, no modification of the severity of paralysis by gamma globulin was shown. Nevertheless, the committee cannot say that the use of gamma globulin by mass inoculation produced no effect.

In order to resolve the questions concerning the efficacy of mass use of gamma globulin, further study with standardized material and proper controls would be required. It should, moreover, be pointed out that the efficient use of mass inoculation of gamma globulin in juvenile populations during poliomyelitis epidemics as a control measure is beset with difficulties, and an effective program is not easily set in motion, nor can its effects be easily measured.

Figure 1A. Total weekly poliomyelitis incidence rates per 100,000 population, Montgomery County, Ala., 1953, by week of report, and paralytic status of cases, by week of onset.

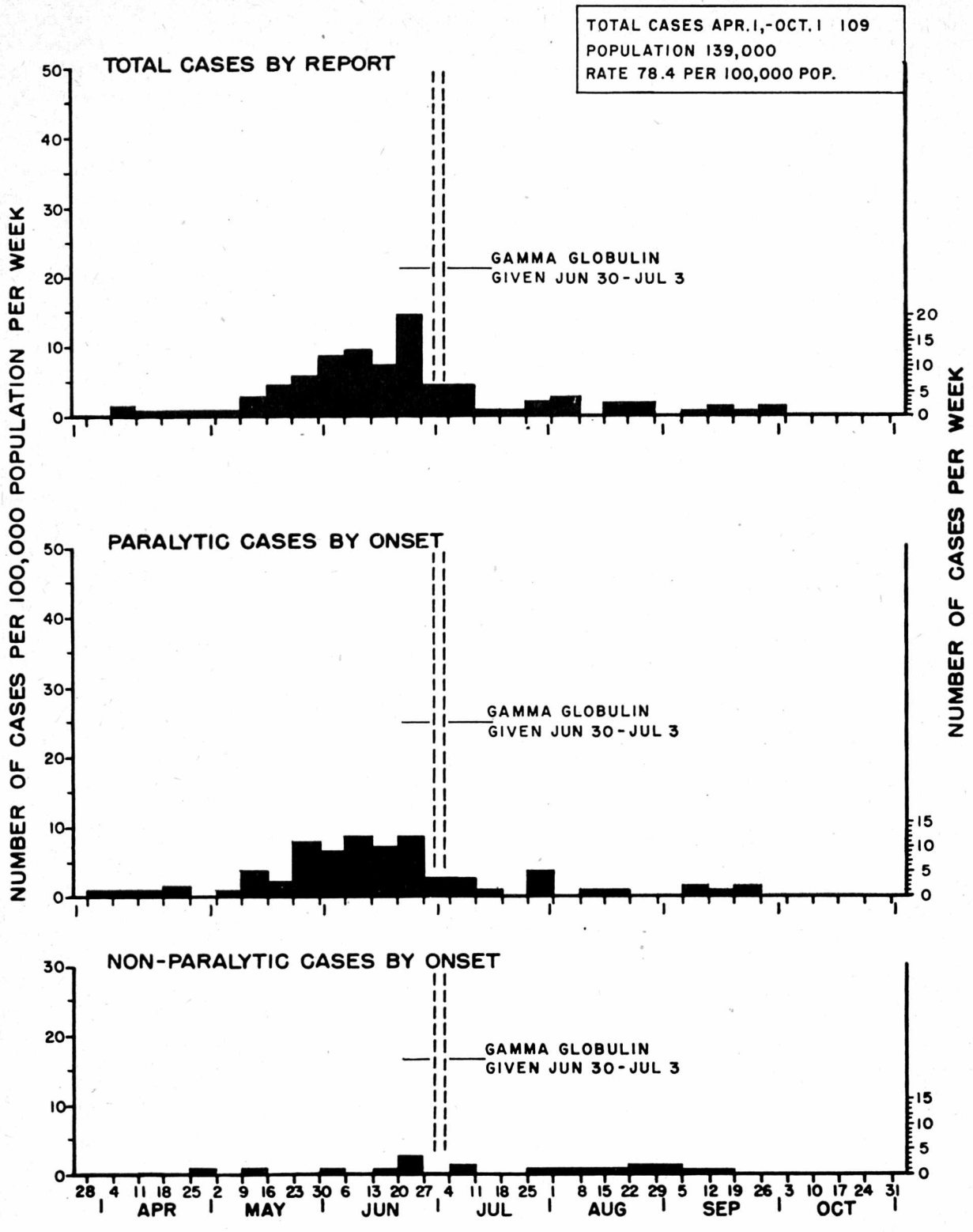


Figure 1B. Number of cases of poliomyelitis, Montgomery County, Ala., 1953, by week of onset, age group, and paralytic status.

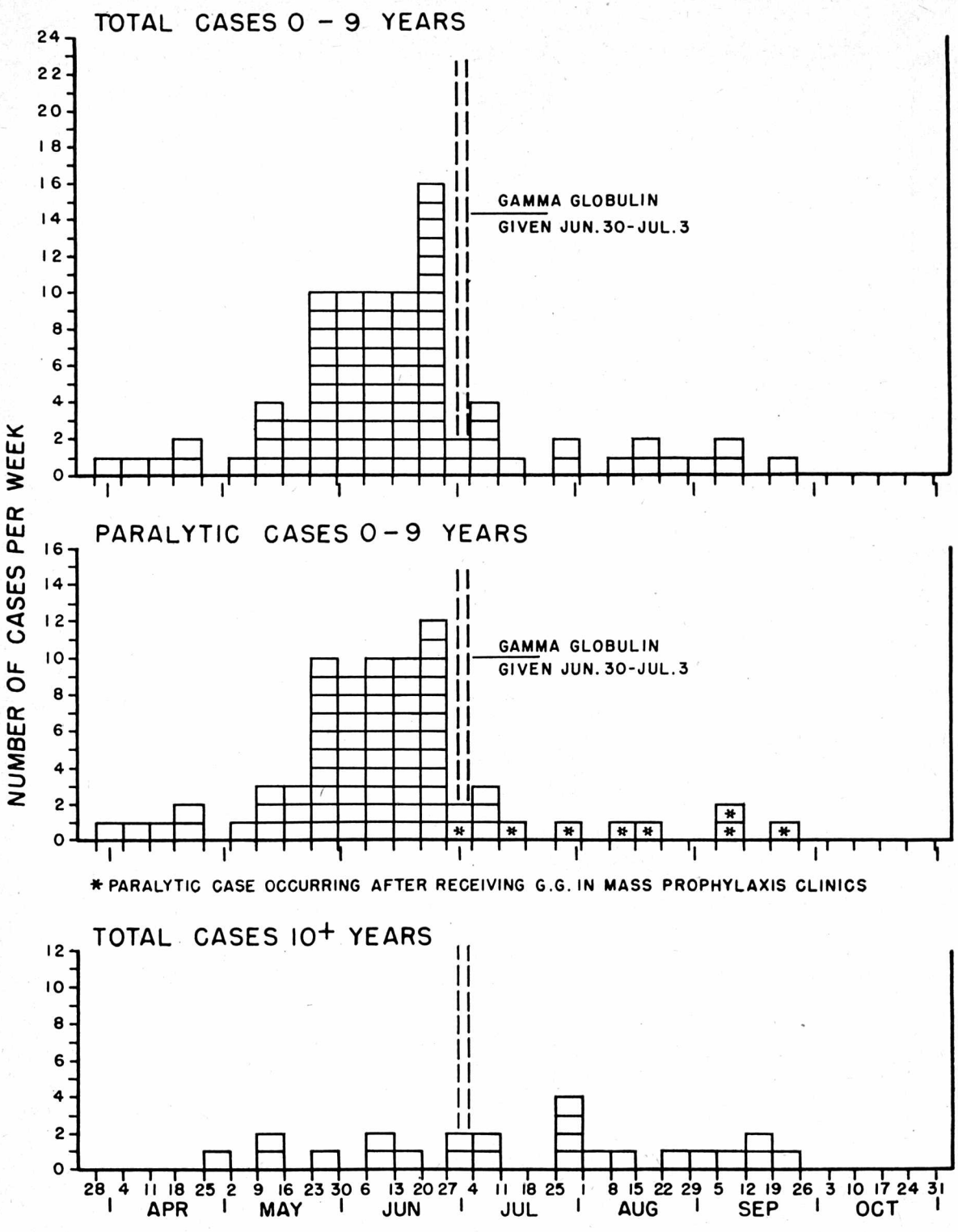


Figure 2A. Total weekly poliomyelitis incidence rates per 100,000 population, Caldwell County, N. C., 1953, by week of report, and paralytic status of cases, by week of onset.

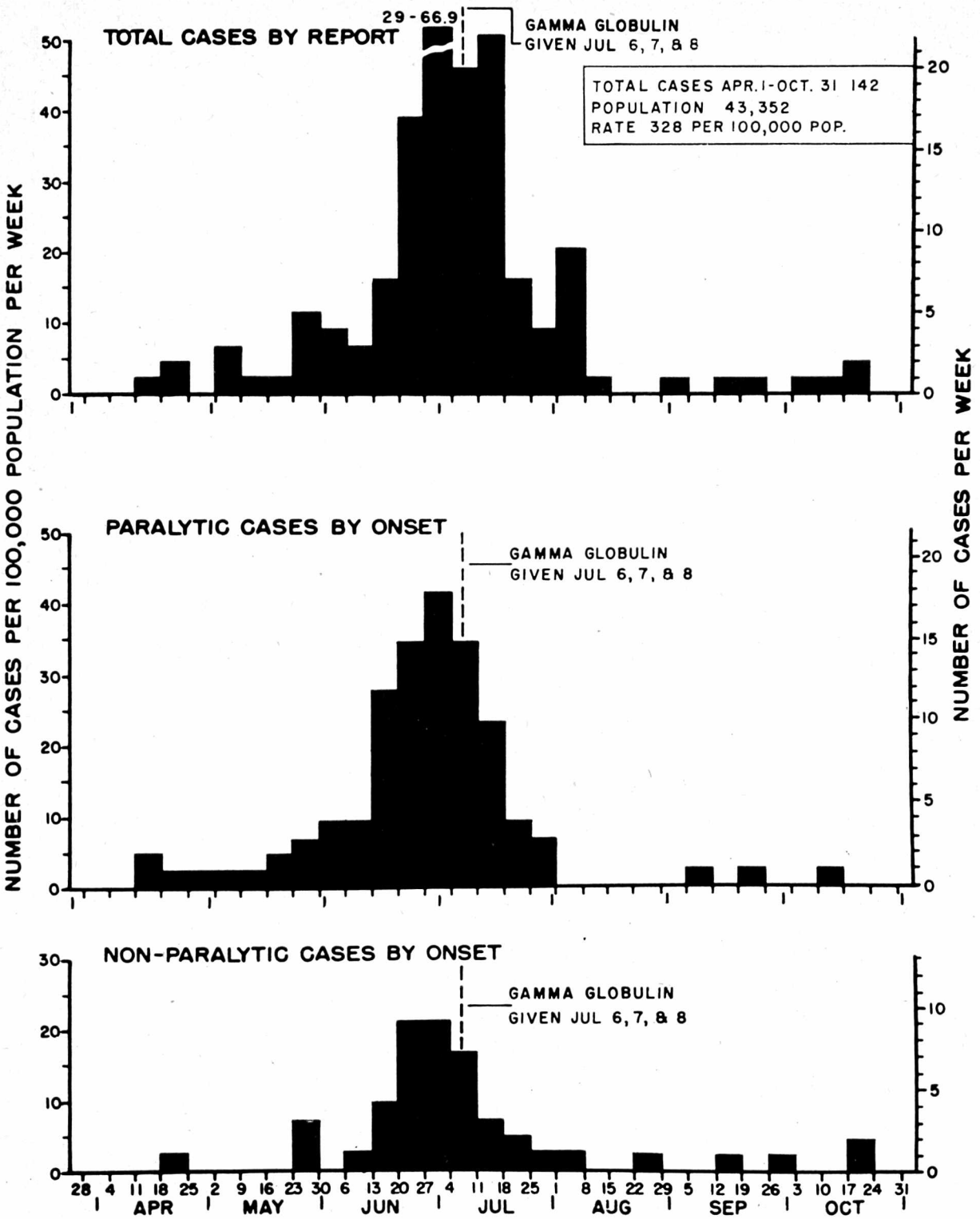


Figure 2B. Number of cases of poliomyelitis, Caldwell County, N. C., 1953, by week of onset, age group, and paralytic status.

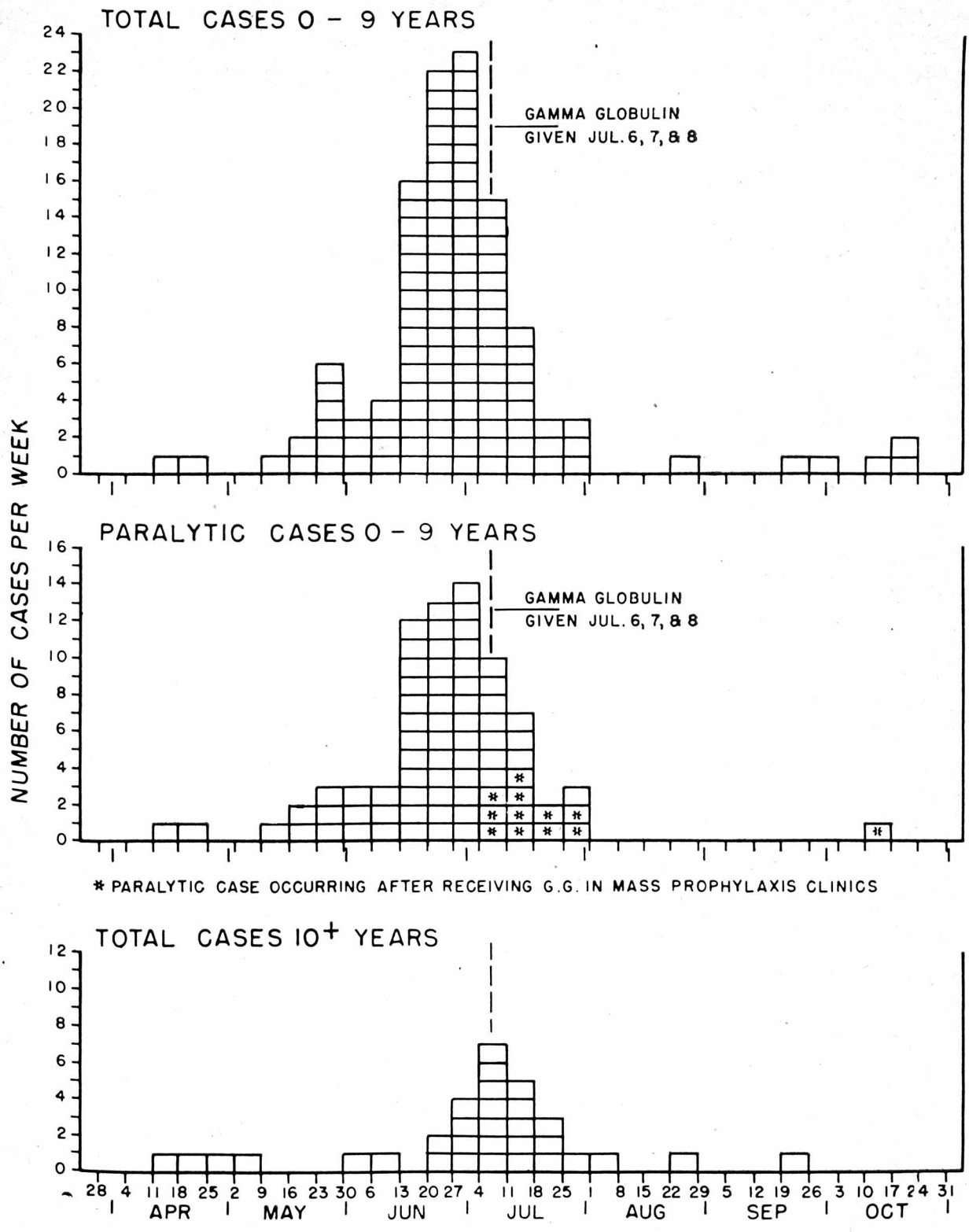


Figure 3A. Total weekly poliomyelitis incidence rates per 100,000 population, Chemung County, N. Y., 1953, by week of onset, and paralytic status.

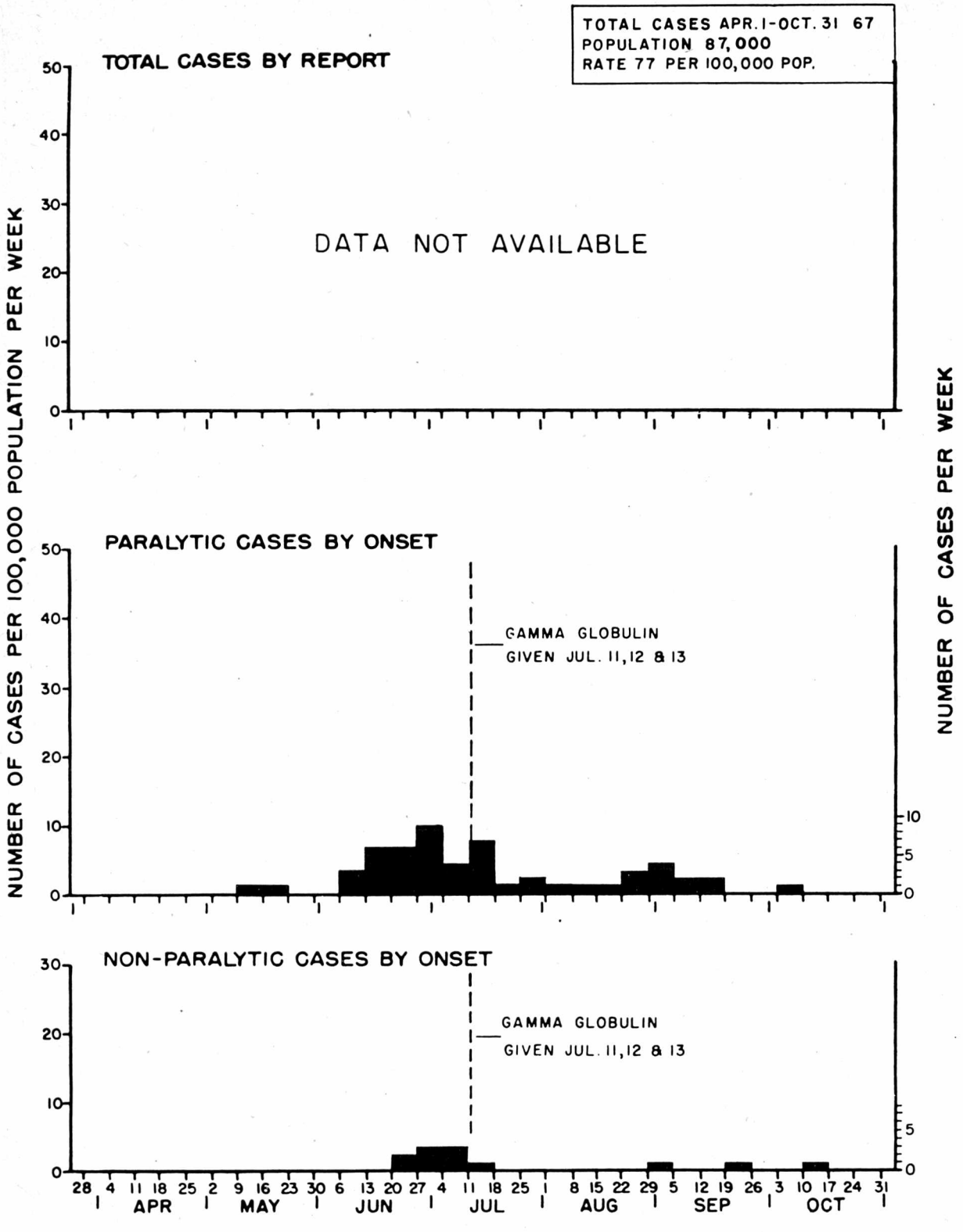
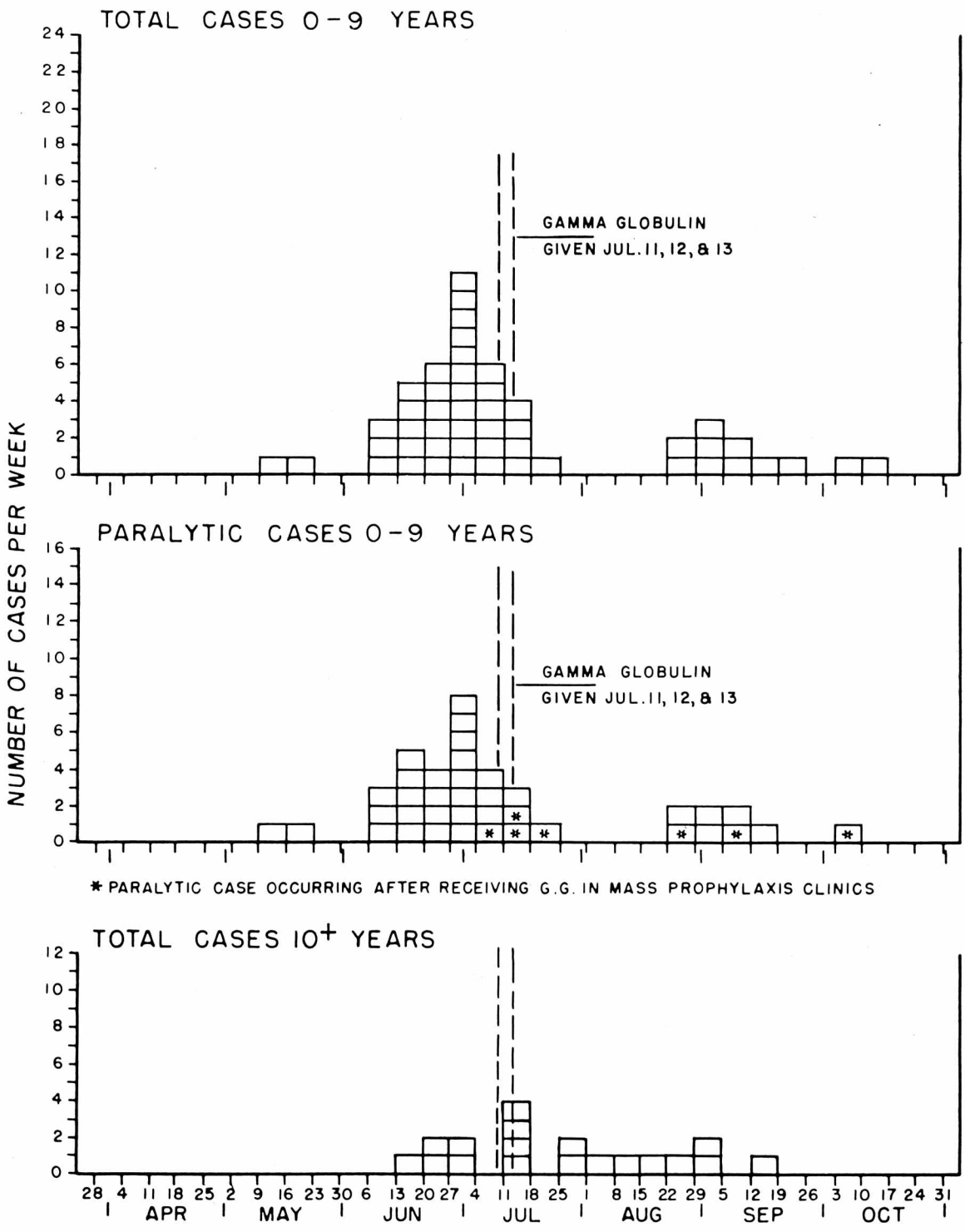


Figure 3B. Number of cases of poliomyelitis per week, Chemung County, N. Y., 1953, by week of onset, age group, and paralytic status.





294578—54——3

Figure 4A. Total weekly poliomyelitis incidence rates per 100,000 population, Steuben County, N. Y., 1953, by week of onset, and paralytic status.

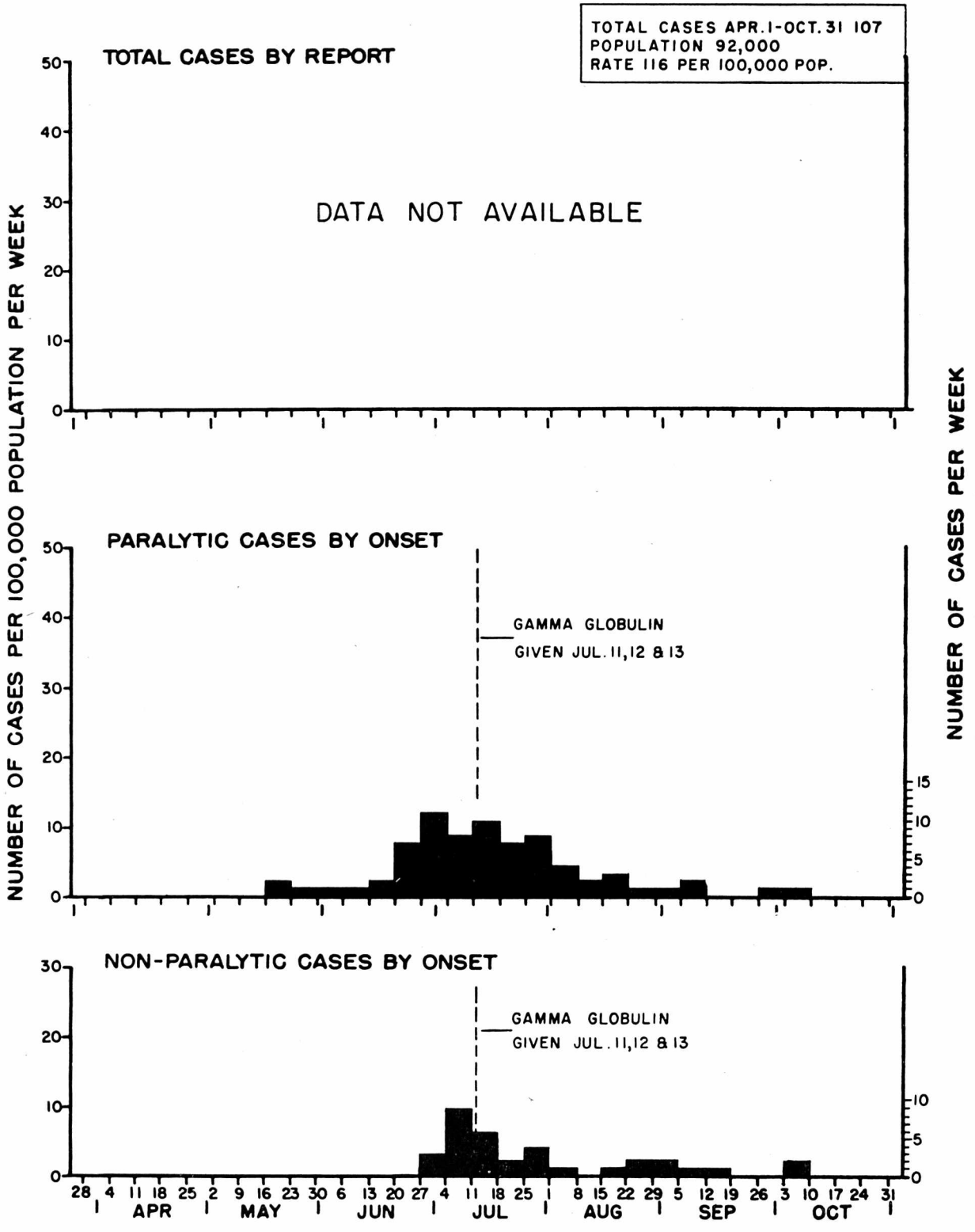


Figure 4B. Number of cases of poliomyelitis per week, Steuben County, N. Y., 1953. by week of onset, age group, and paralytic status.

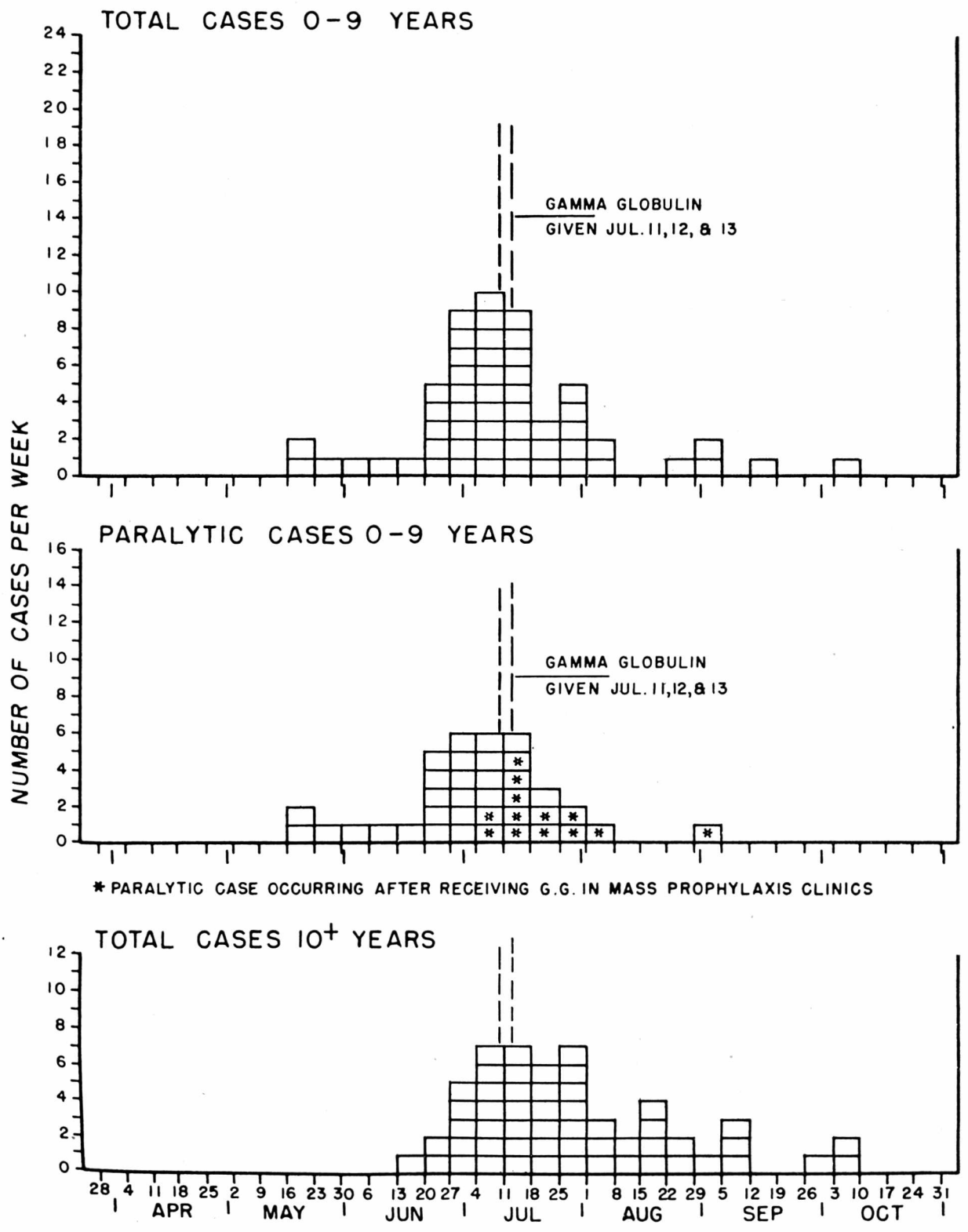


Figure 5A. Total weekly poliomyelitis incidence rates per 100,000 population, Catawba County, N C., 1953, by week of report, and paralytic status of cases, by week of onset.

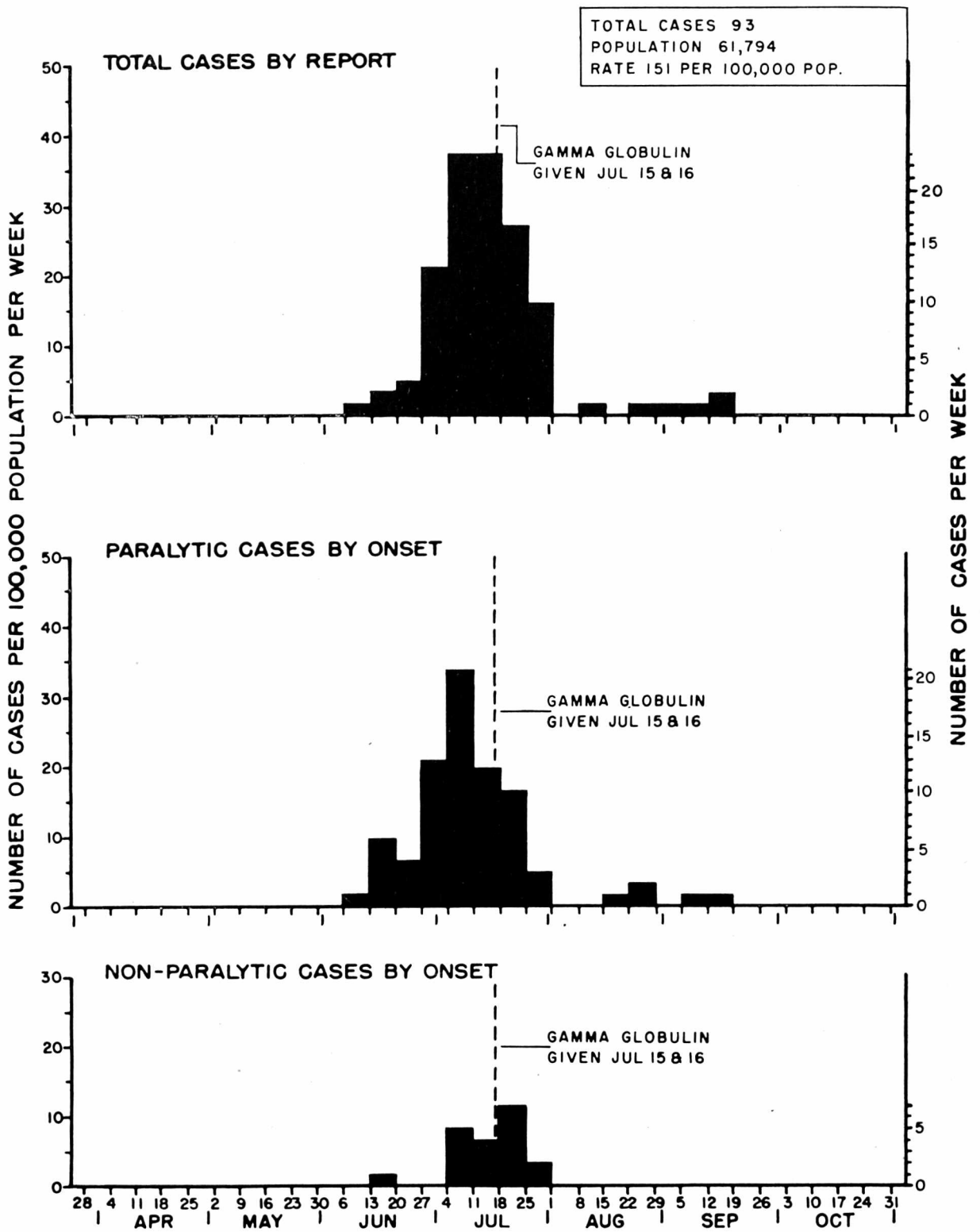


Figure 5B. Number of poliomyelitis cases, Catawba County, N. C., by week of onset, age group, and paralytic status.

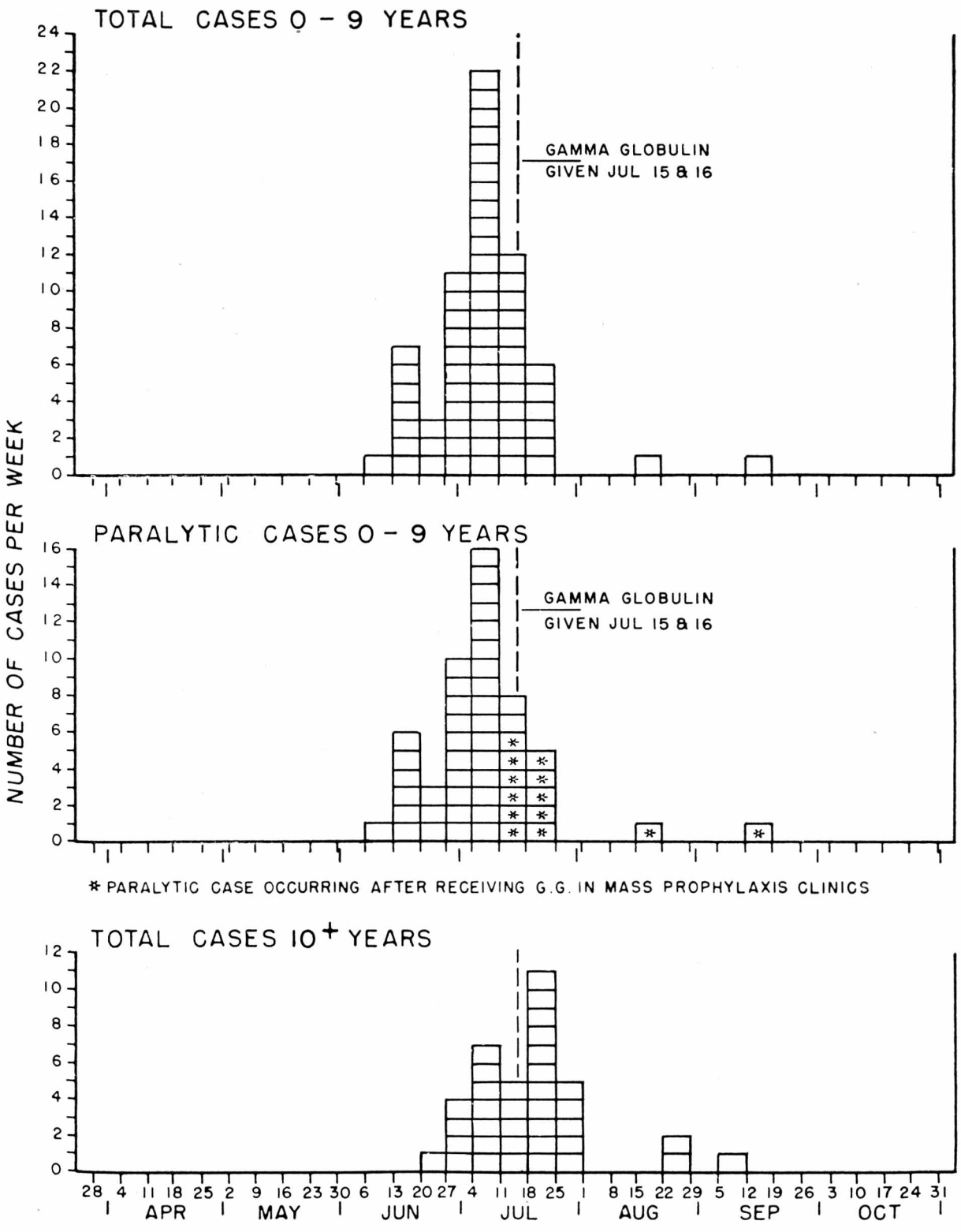


Figure 6A. Total weekly poliomyelitis incidence rates per 100,000 population, Macon County, Ill., 1953, by week of report, and paralytic status of cases, by week of onset.

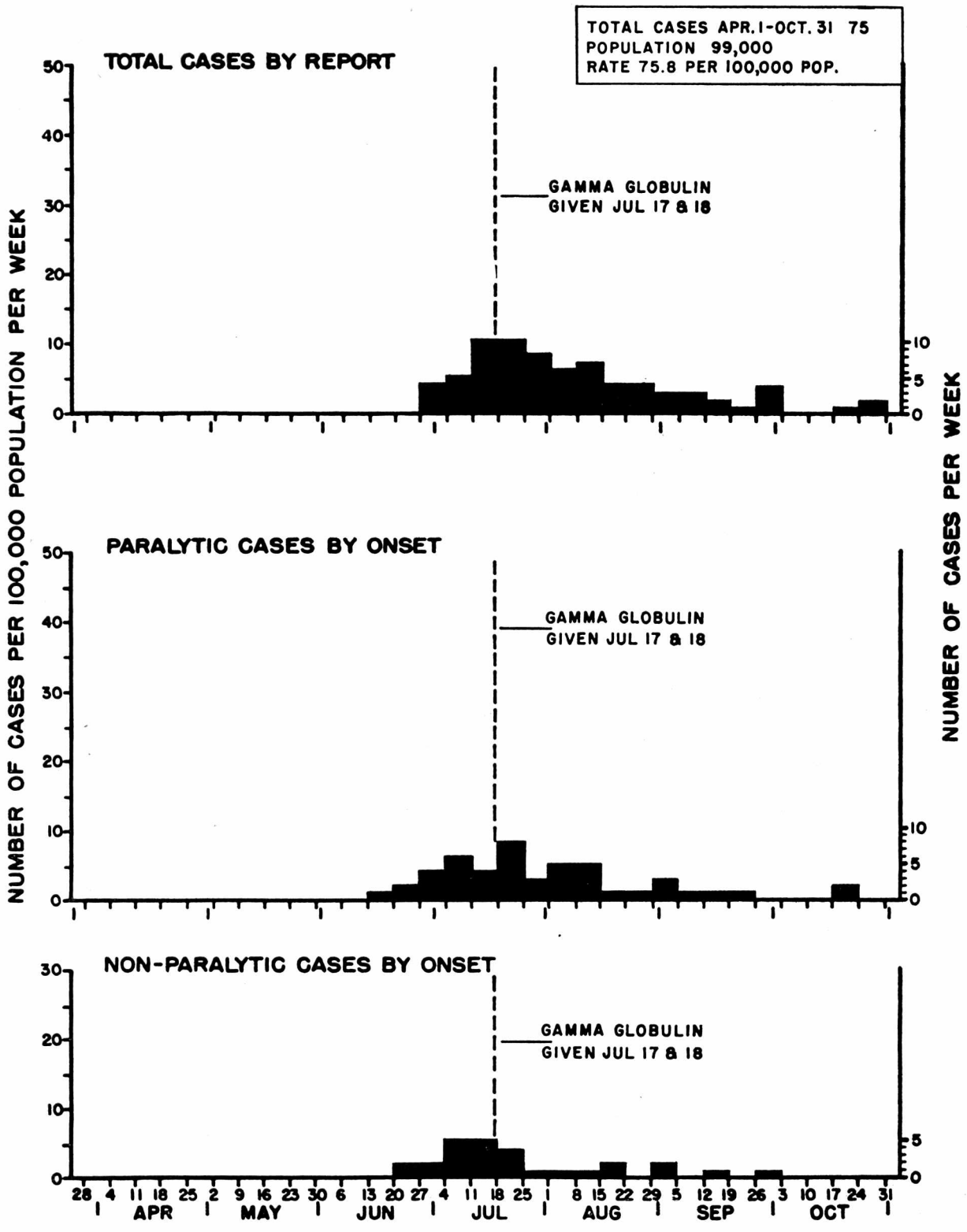


Figure 6B. Number of poliomyelitis cases, Macon County, Ill., 1953, by week of onset, age group, and paralytic status.

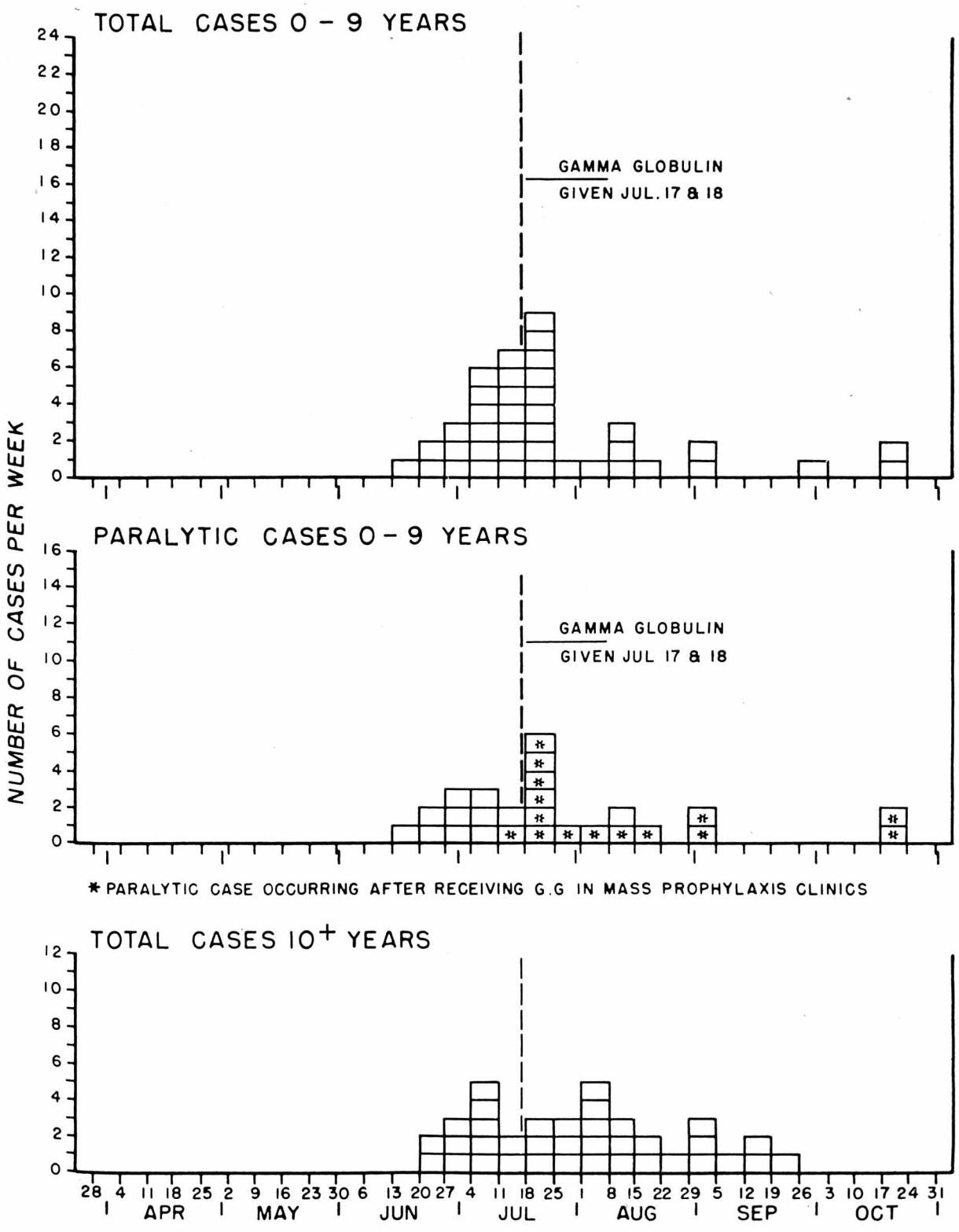


Figure 7A. Total weekly poliomyelitis incidence rates per 100,000 population, Washington County, Va., 1953, by week of onset, and paralytic status.

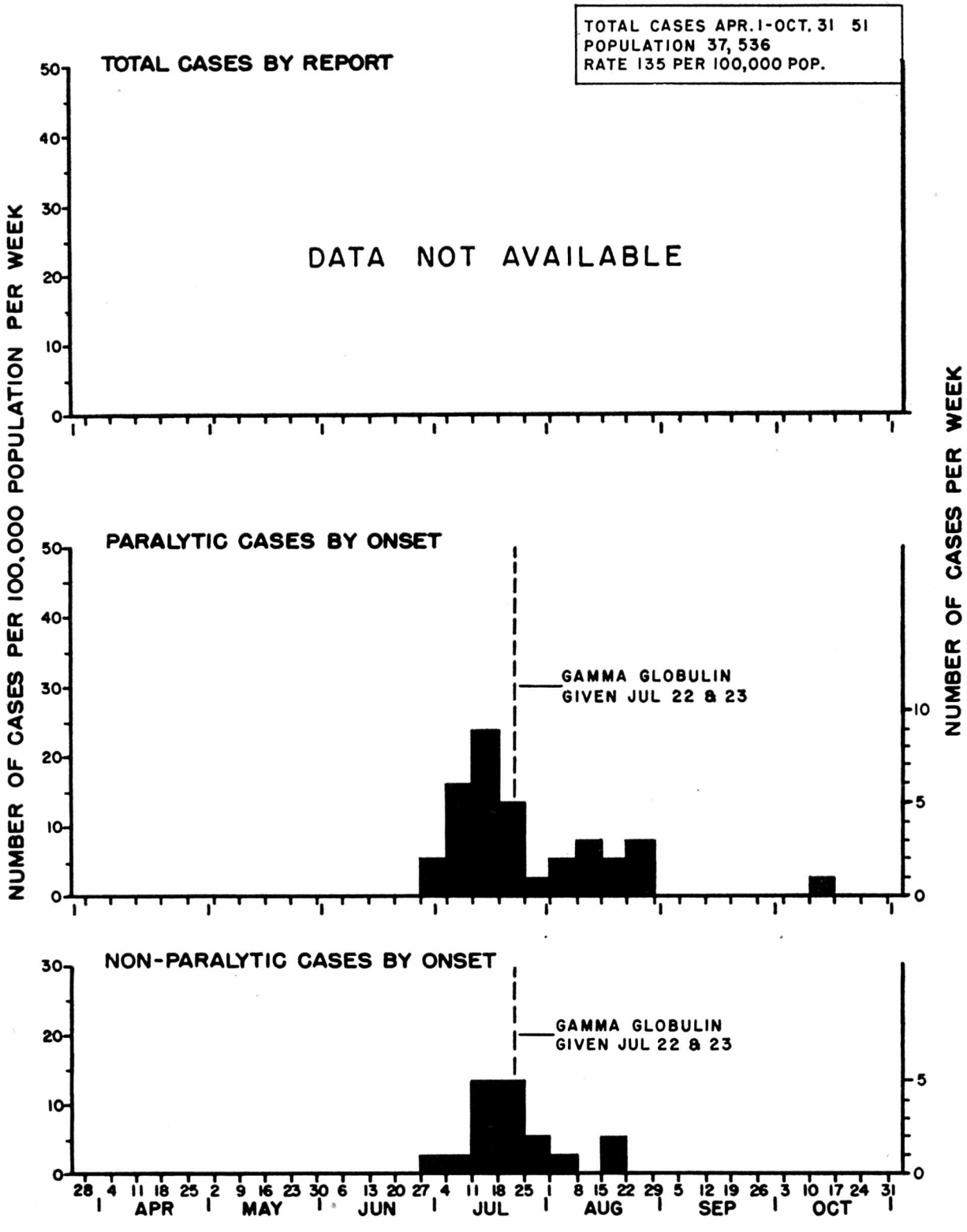
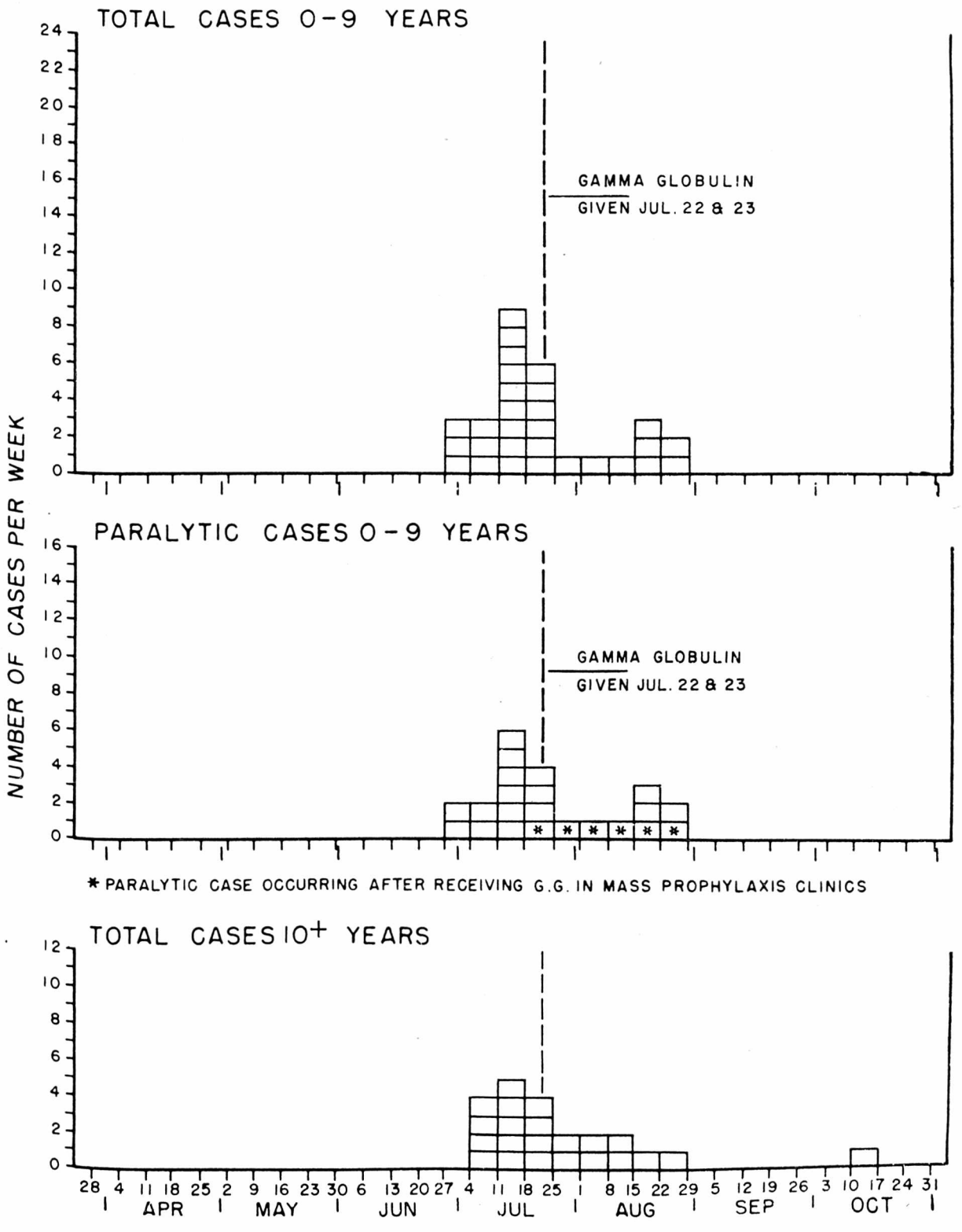


Figure 7B. Number of poliomyelitis cases, Washington County, Va., 1953, by week of onset, age group, and paralytic status.





294578—54——4

Figure 8A. Total weekly poliomyelitis incidence rates per 100,000 population, Bristol, Va. and Tenn., 1953, by week of onset, and paralytic status.

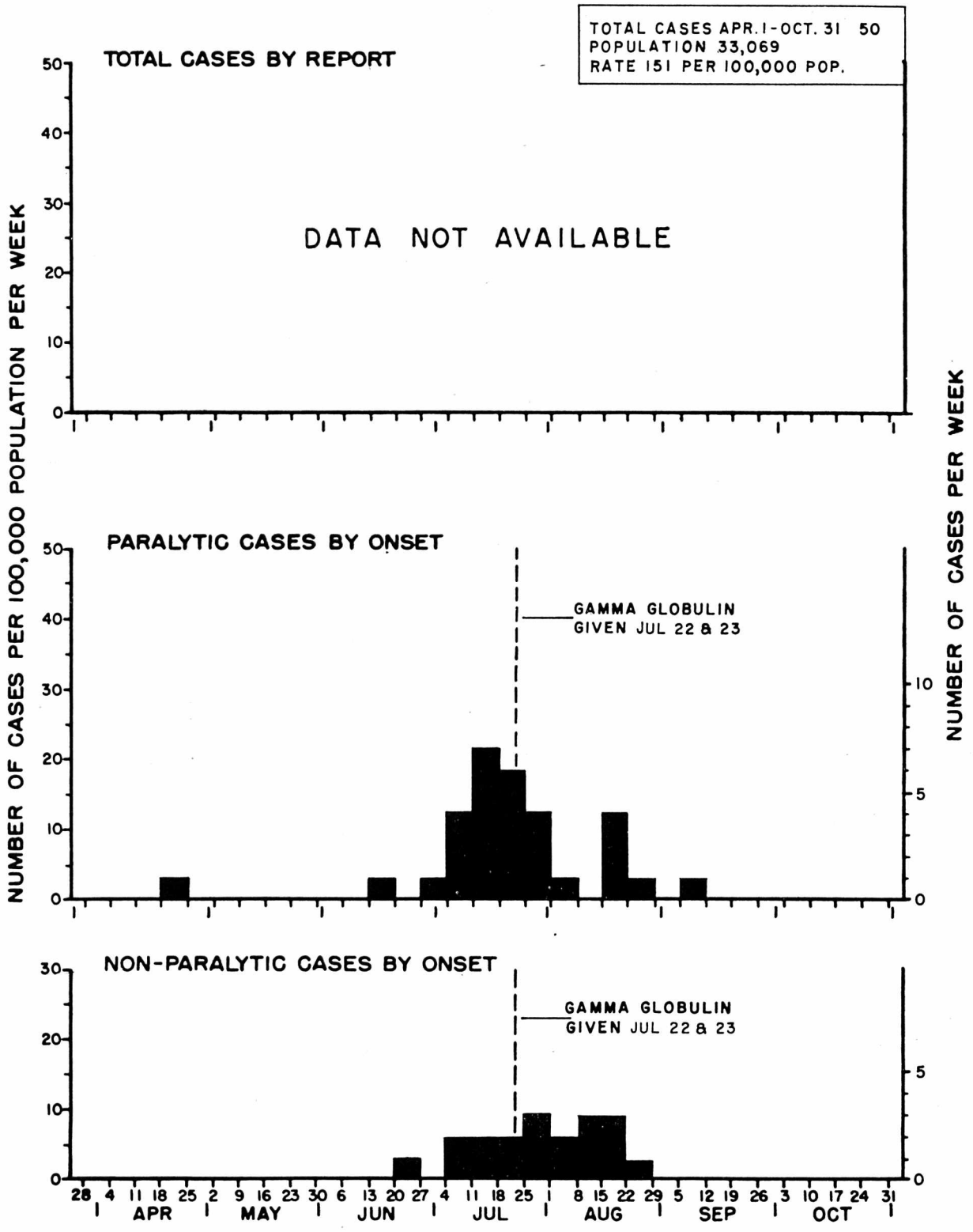


Figure 8B. Number of poliomyelitis cases, Bristol, Va. and Tenn., 1953, by week of onset, age group, and paralytic status.

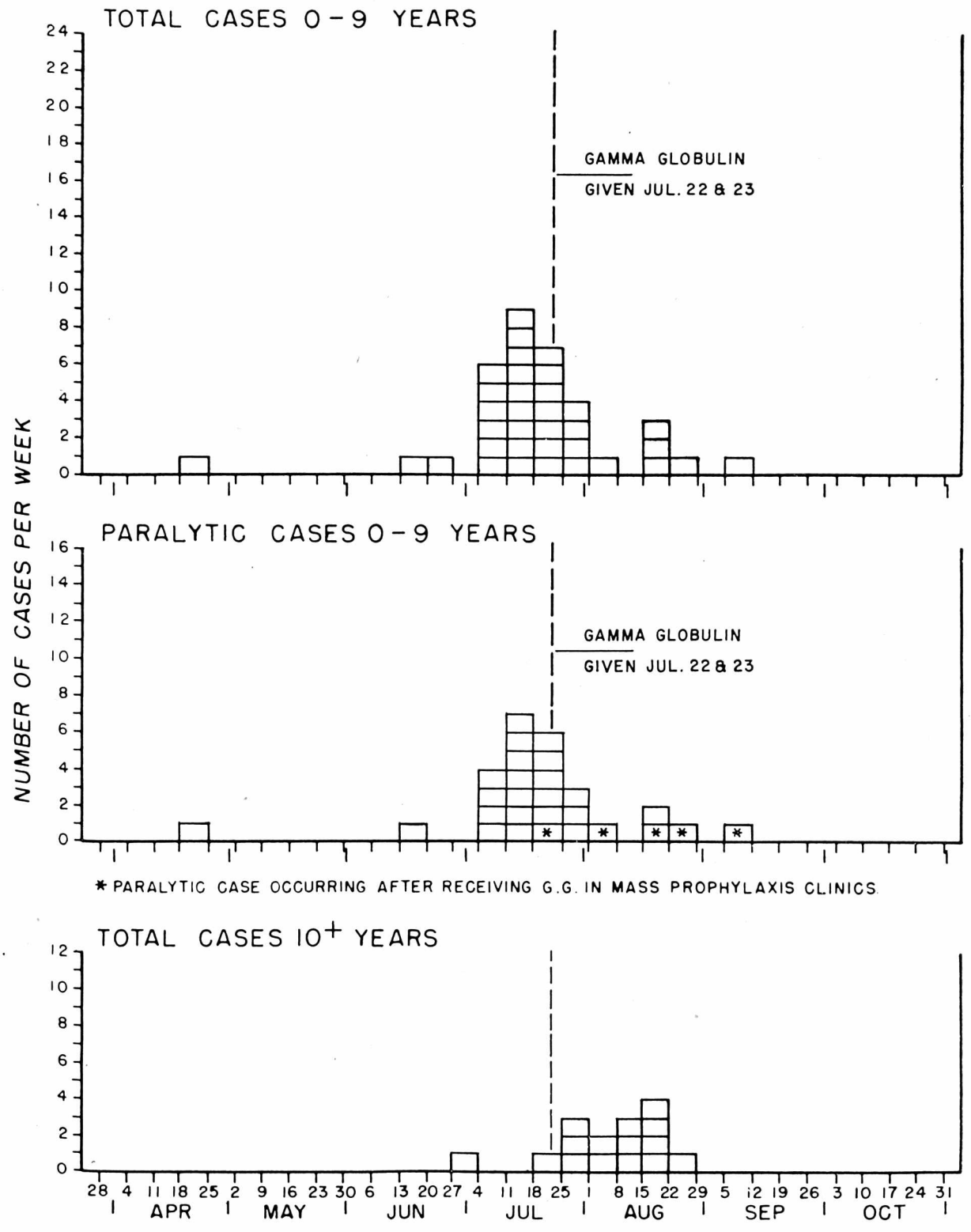


Figure 9A. Total weekly poliomyelitis incidence rates per 100,000 population, Marquette County, Mich., 1953, by week of report, and paralytic status of cases, by week of onset.

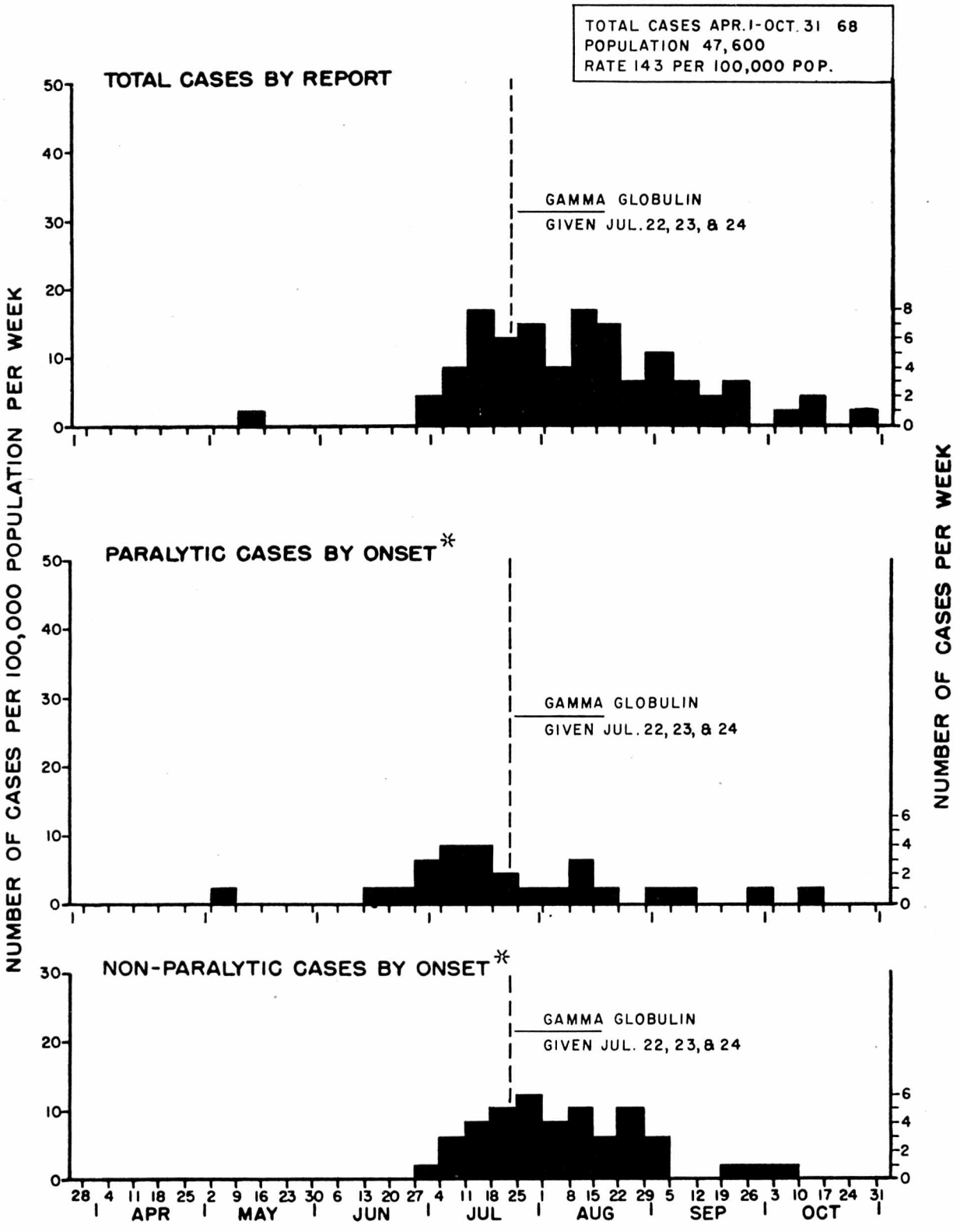


Figure 9B. Number of cases of poliomyelitis per week, Marquette County, Mich., 1953, by week of onset, age group, and paralytic status.

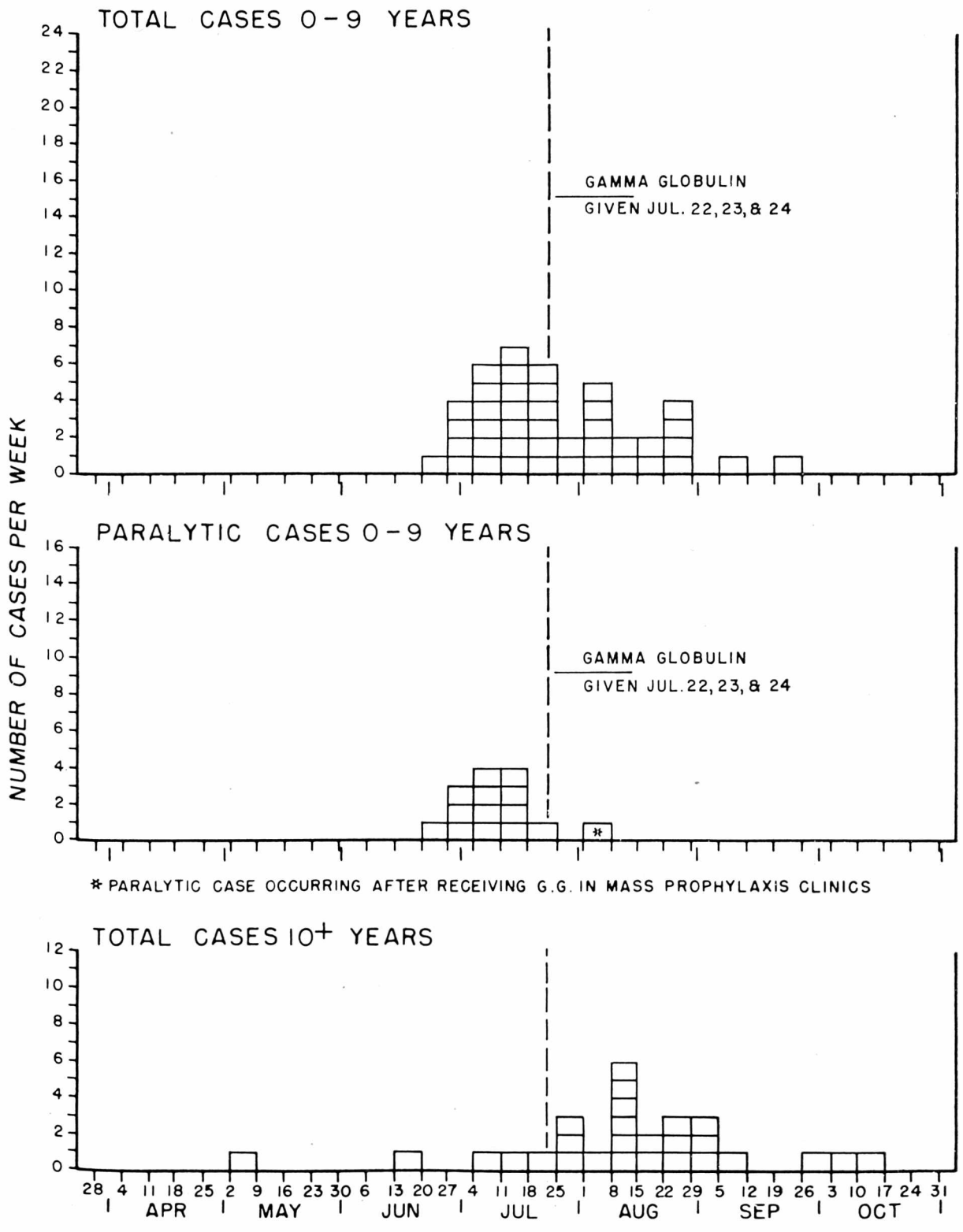


Figure 10A. Total weekly poliomyelitis incidence rates per 100,000 population, Carter County, Tenn., 1953, by week of report, and paralytic status of cases, by week of onset.

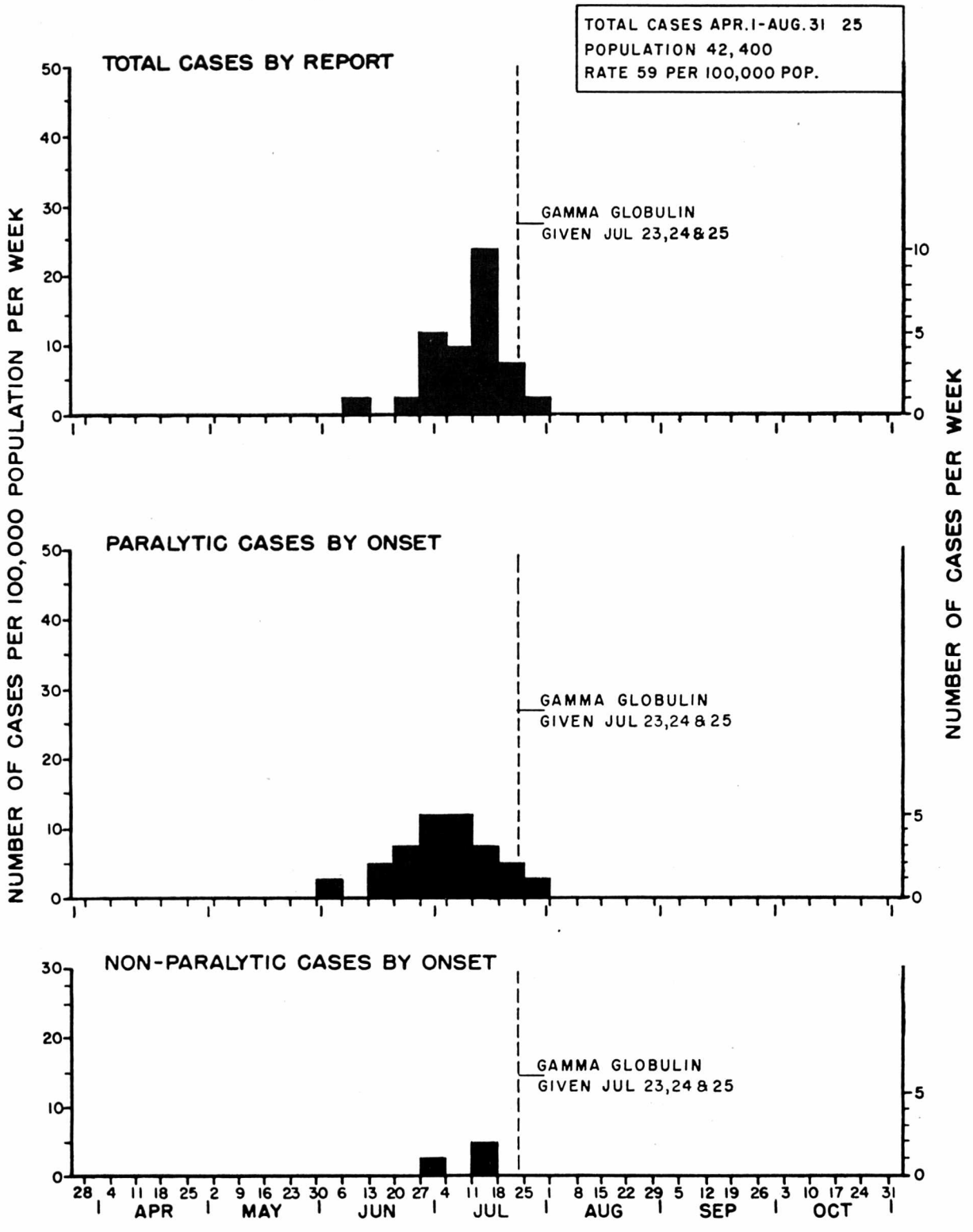


Figure 10B. Number of poliomyelitis cases per week, Carter County, Tenn., by week of onset, age group, and paralytic status.

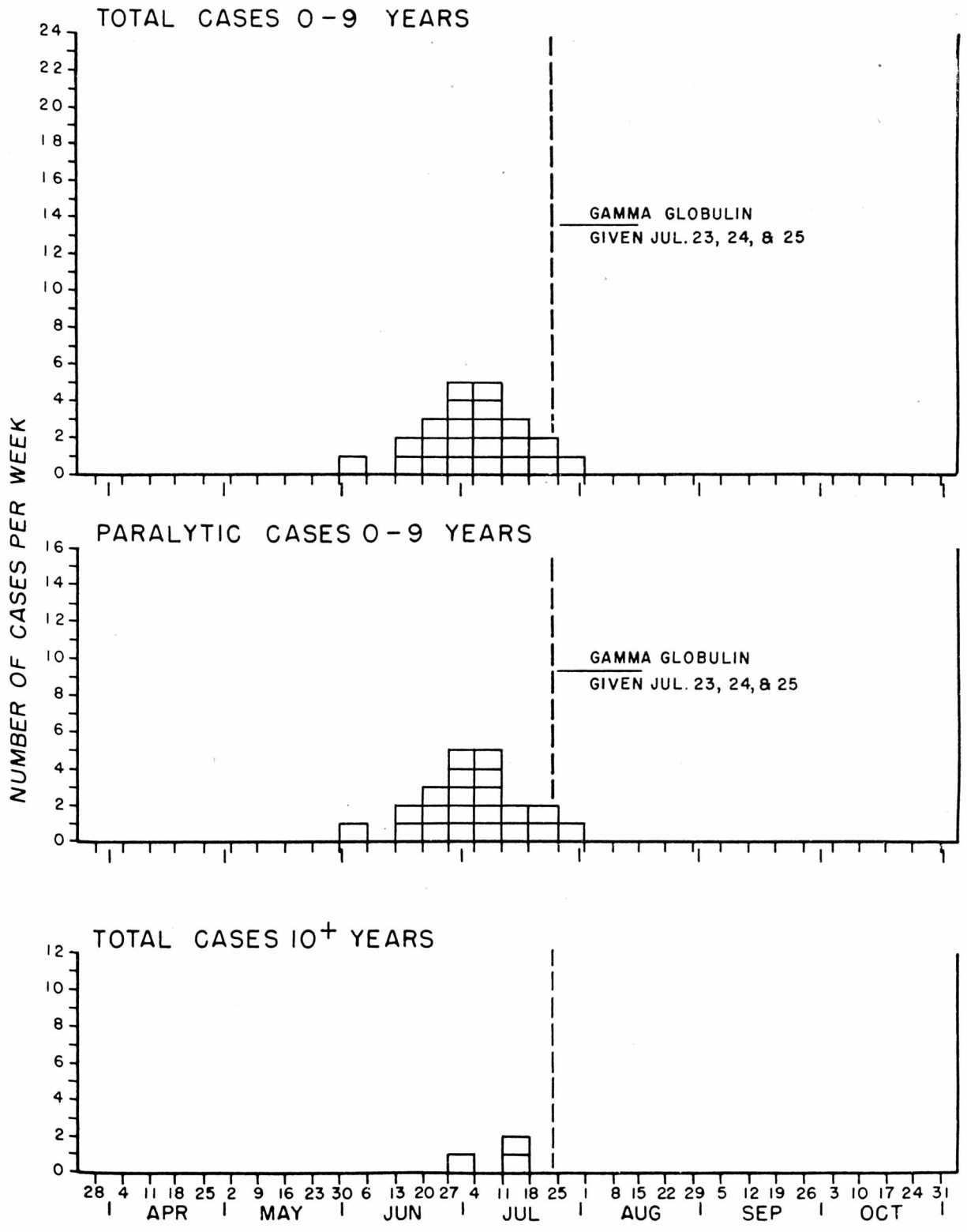


Figure 11A. Total weekly poliomyelitis incidence rates per 100,000 population, McLean and Daviess Counties, Ky., 1953, by week of report, and paralytic status of cases, by week of onset.

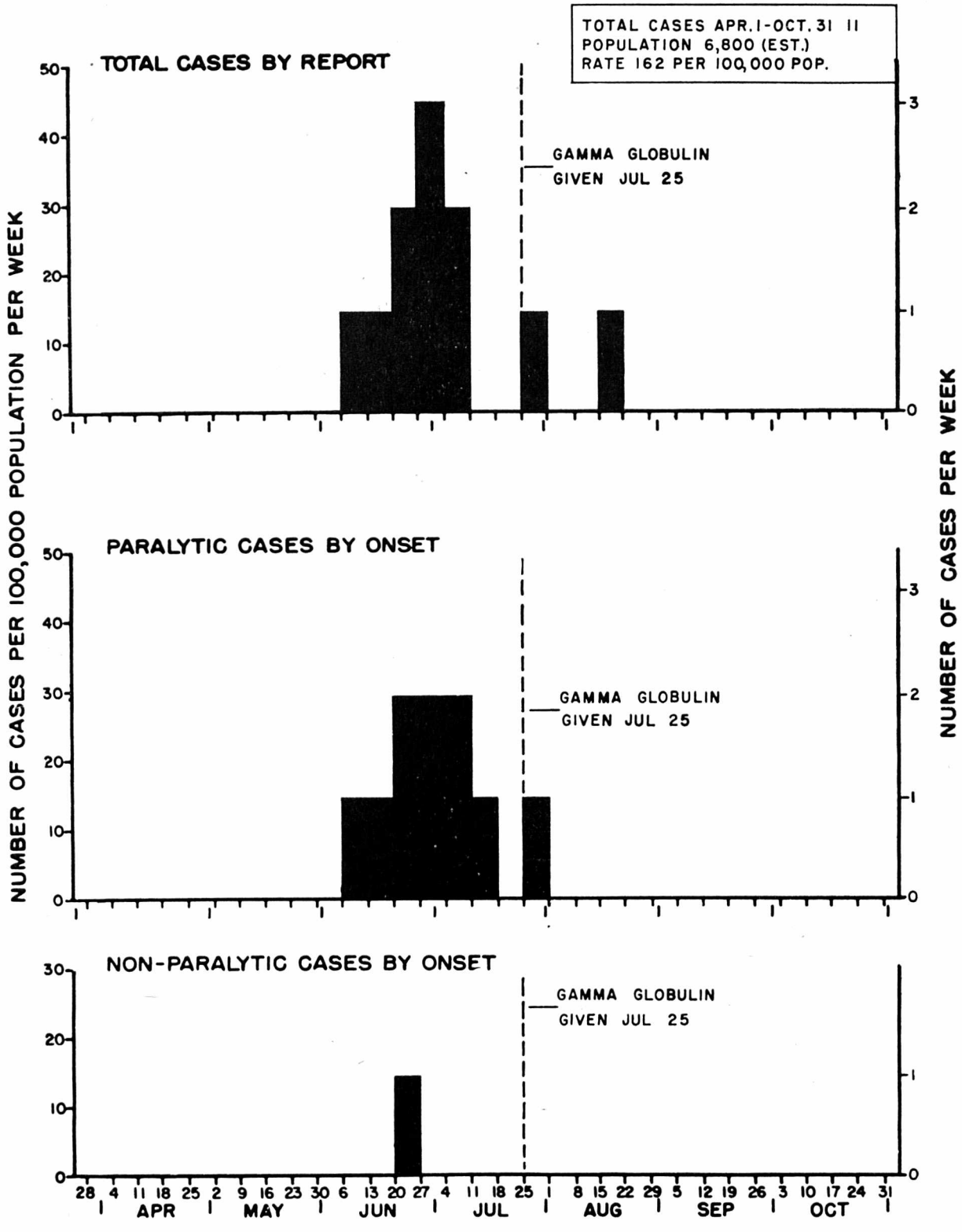


Figure 11B. Number of poliomyelitis cases per week, McLean and Daviess Counties, Ky., 1953, by week of onset, age group, and paralytic status.

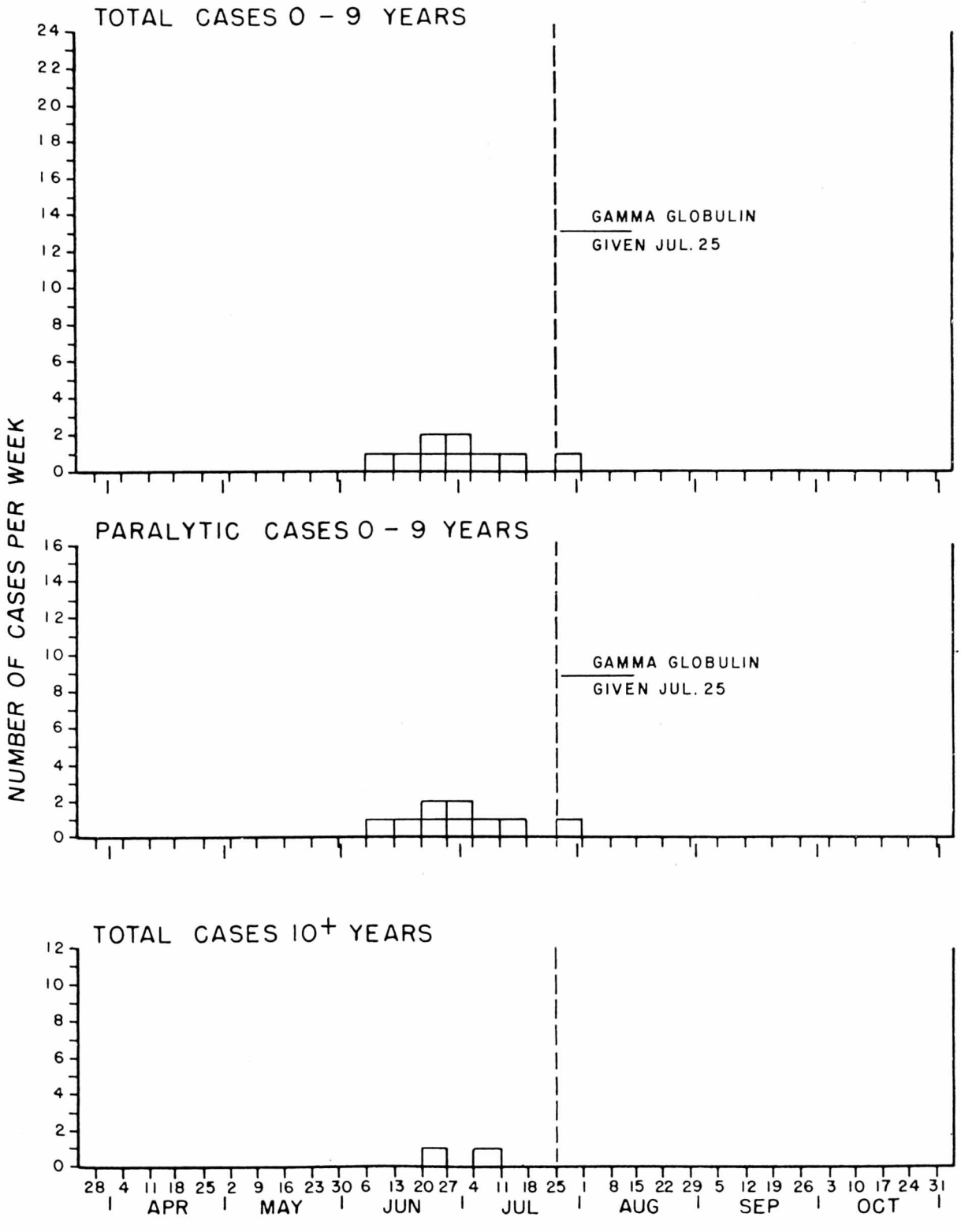


Figure 12A. Total weekly poliomyelitis incidence rates per 100,000 population, Avery County, N. C., 1953, by week of report, and paralytic status of cases, by week of onset.

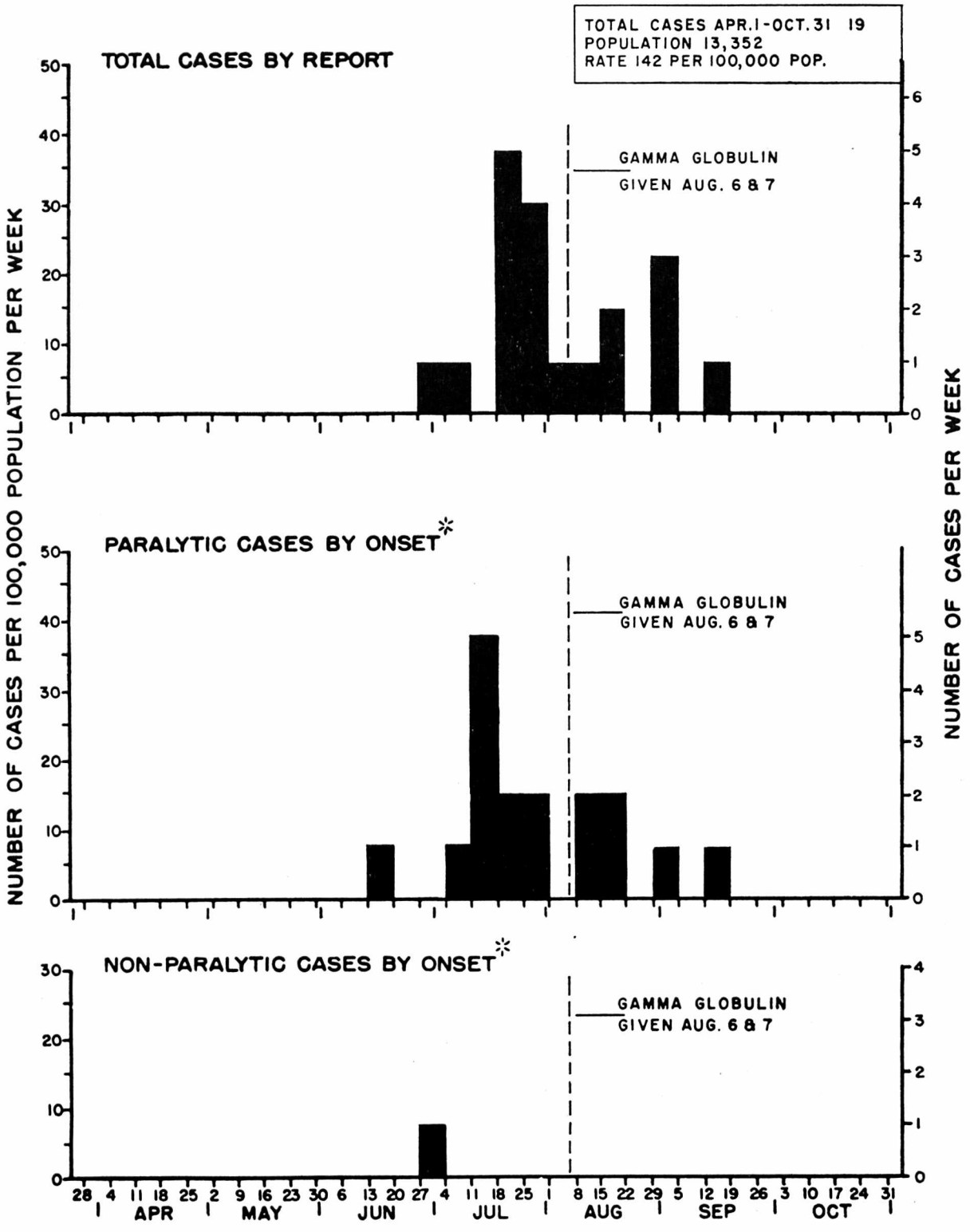


Figure 12B. Number of poliomyelitis cases per week, Avery County, N. C., 1953, by week of onset, age group, and paralytic status.

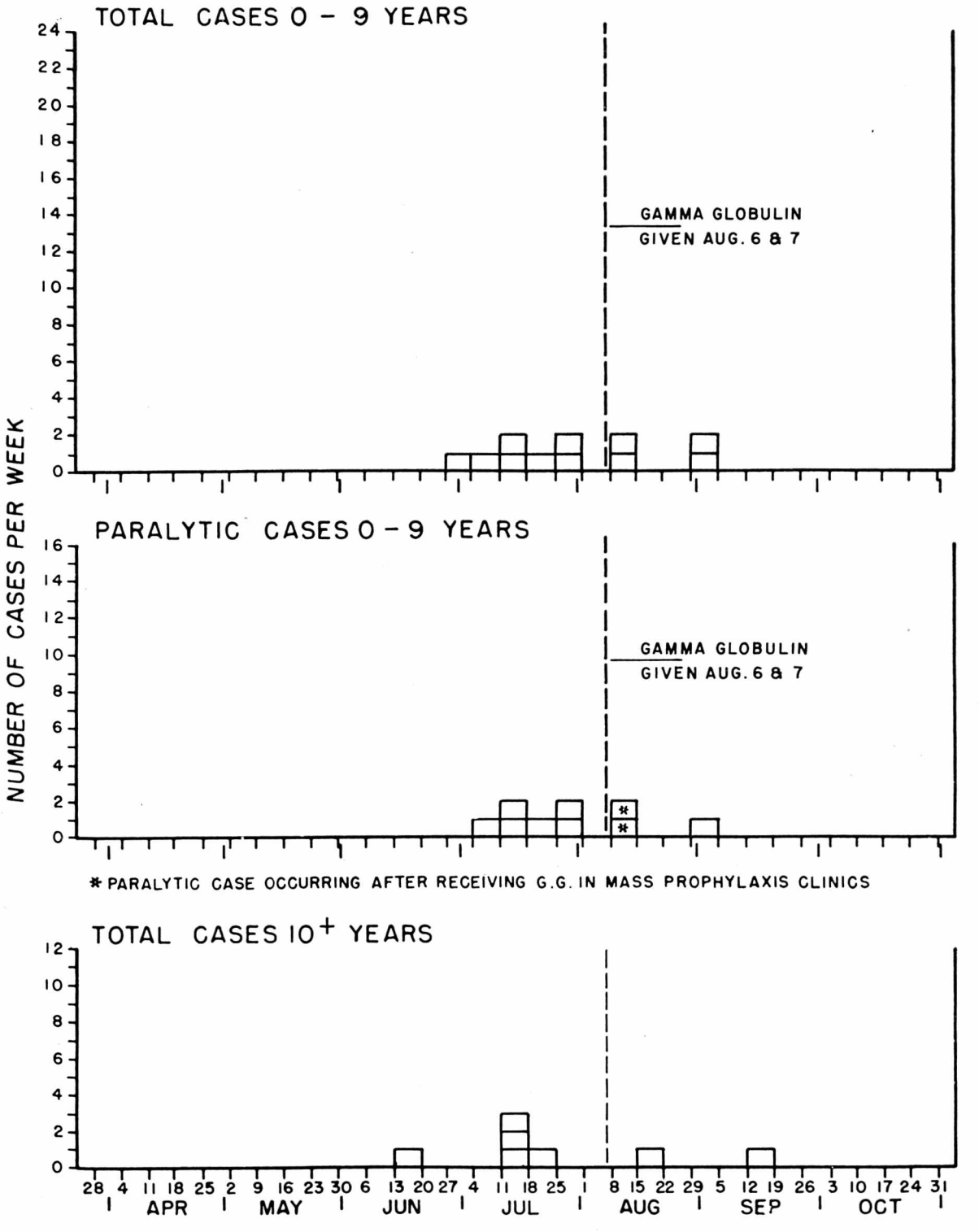


Figure 13A. Total weekly poliomyelitis incidence rates per 100,000 population, Park County, Mont., 1953, by week of report, and paralytic status of cases, by week of onset.

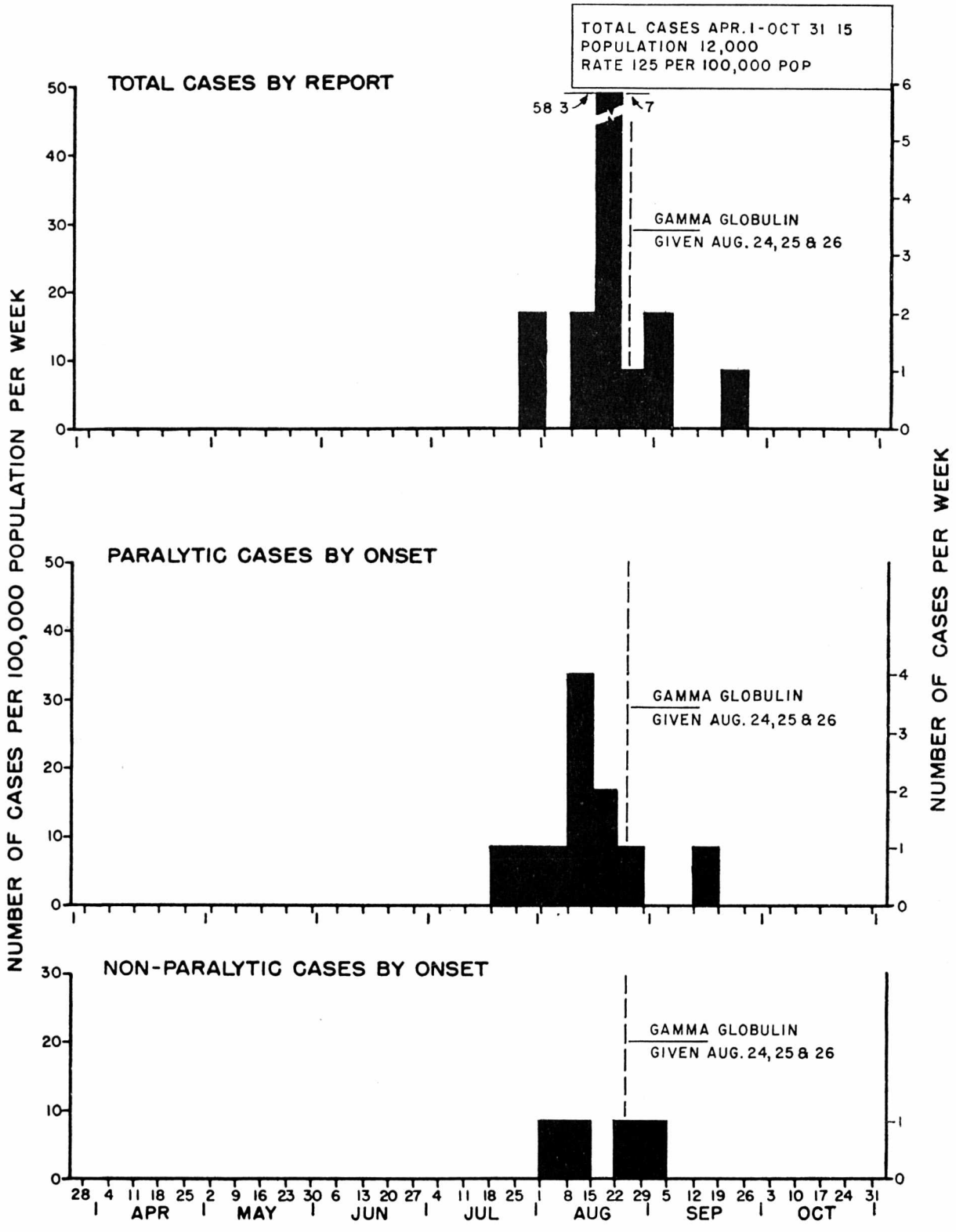


Figure 13B. Number of poliomyelitis cases per week, Park County, Mont., 1953, by week of onset, age group, and paralytic status.

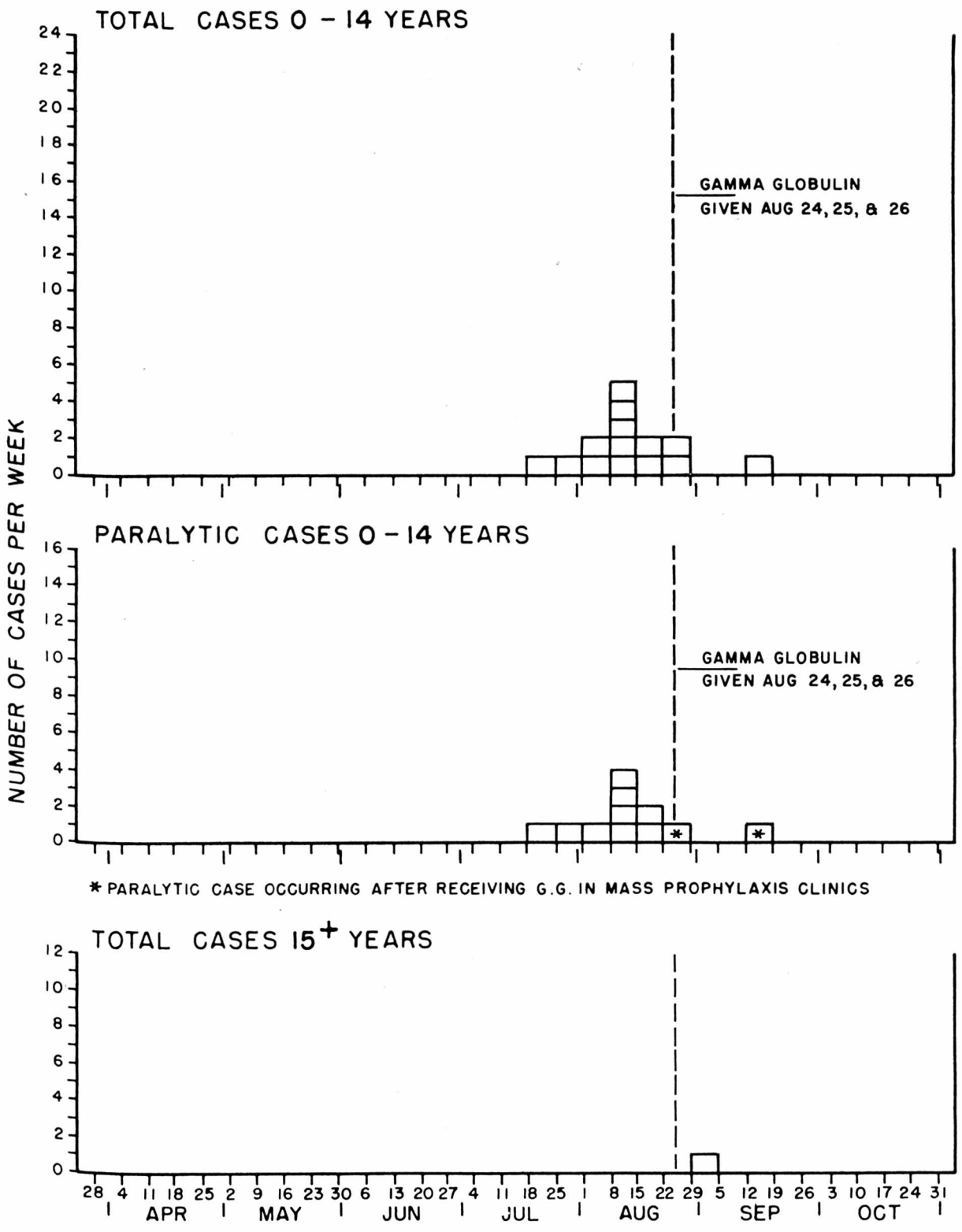


Figure 14A. Total weekly poliomyelitis incidence rates per 100,000 population, Smyth County, Va., 1953, by week of onset, and paralytic status.

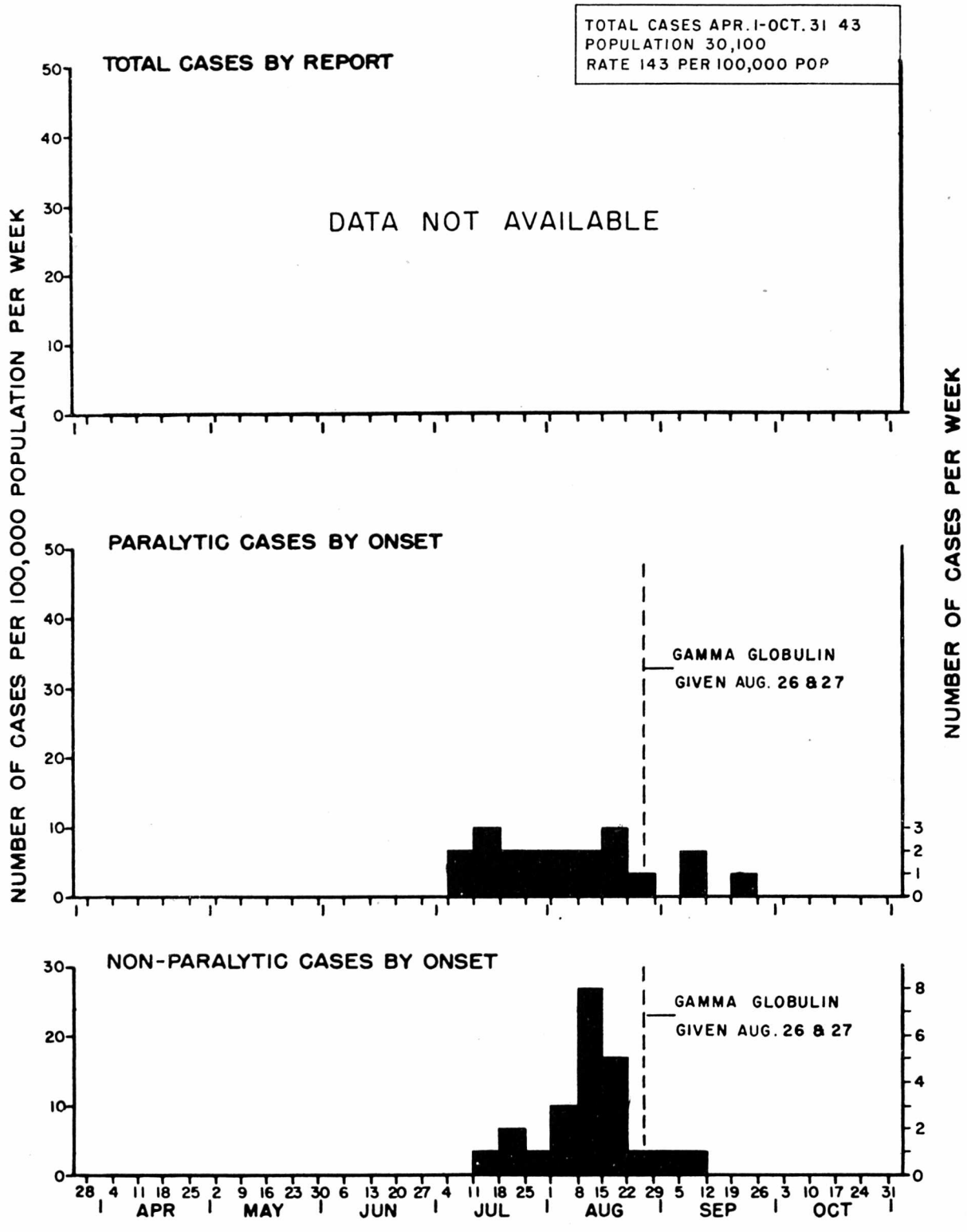


Figure 14B. Number of poliomyelitis cases per week, Smyth County, Va., 1953, by week of onset, age group, and paralytic status of cases.

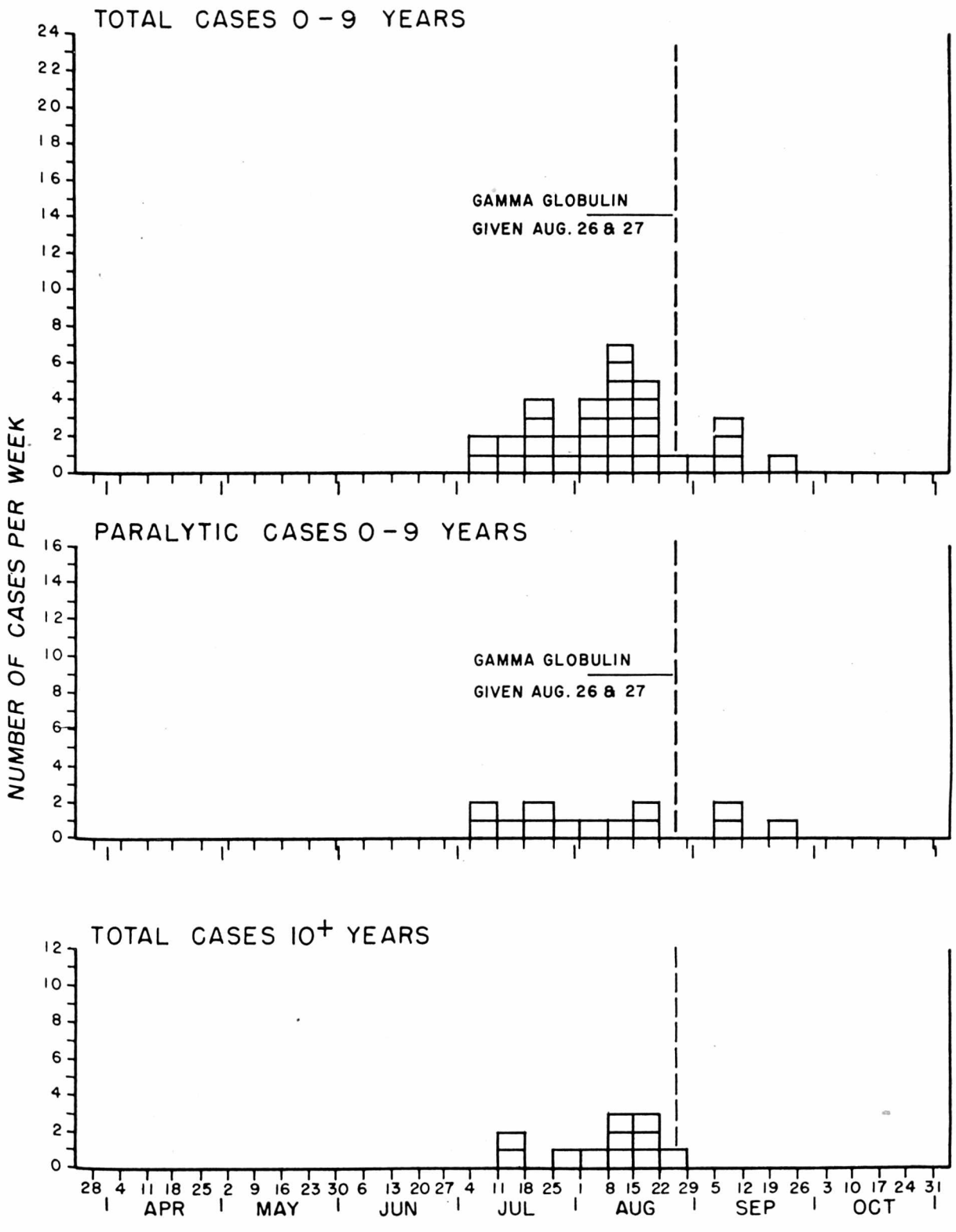


Figure 15A. Total weekly poliomyelitis incidence rates per 100,000 population, Custer County, Mont., 1953, by week of report, and paralytic status of cases, by week of onset.

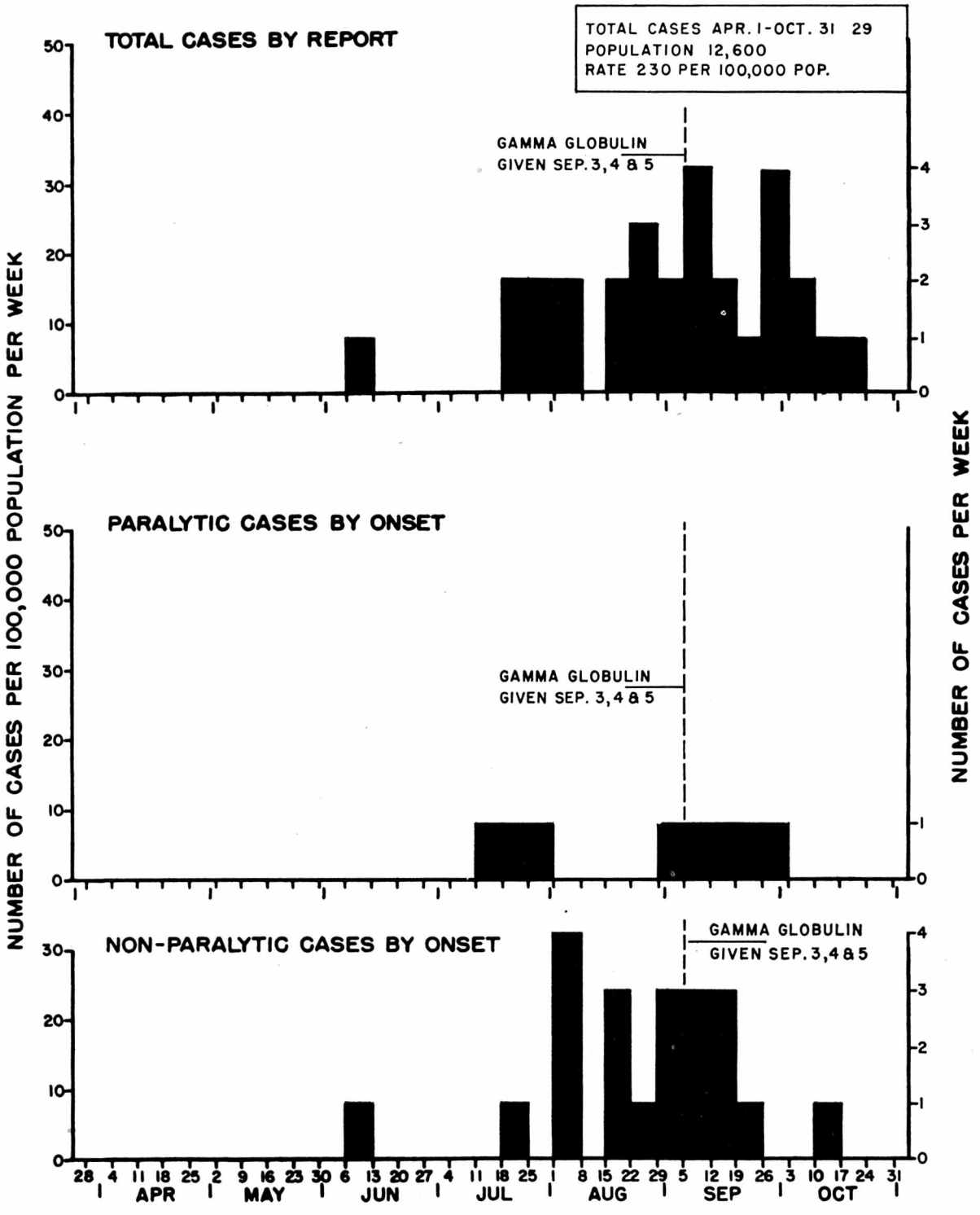


Figure 15B. Number of poliomyelitis cases per week, Custer County, Mont., 1953, by week of onset, age group, and paralytic status.

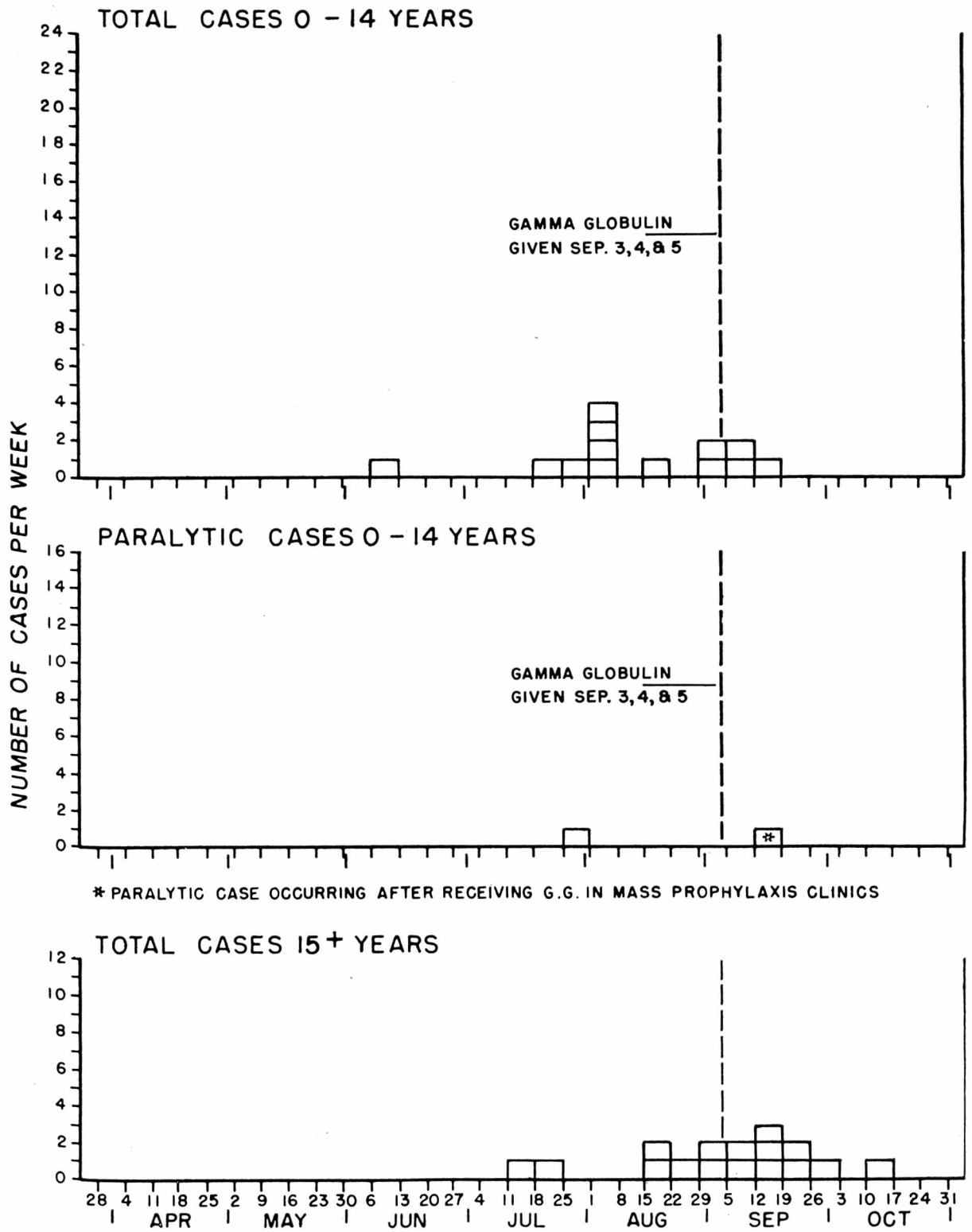


Figure 16A. Total weekly poliomyelitis incidence rates per 100,000 population, Stearns County, Minn., 1953, by week of report, and paralytic status of cases, by week of onset.

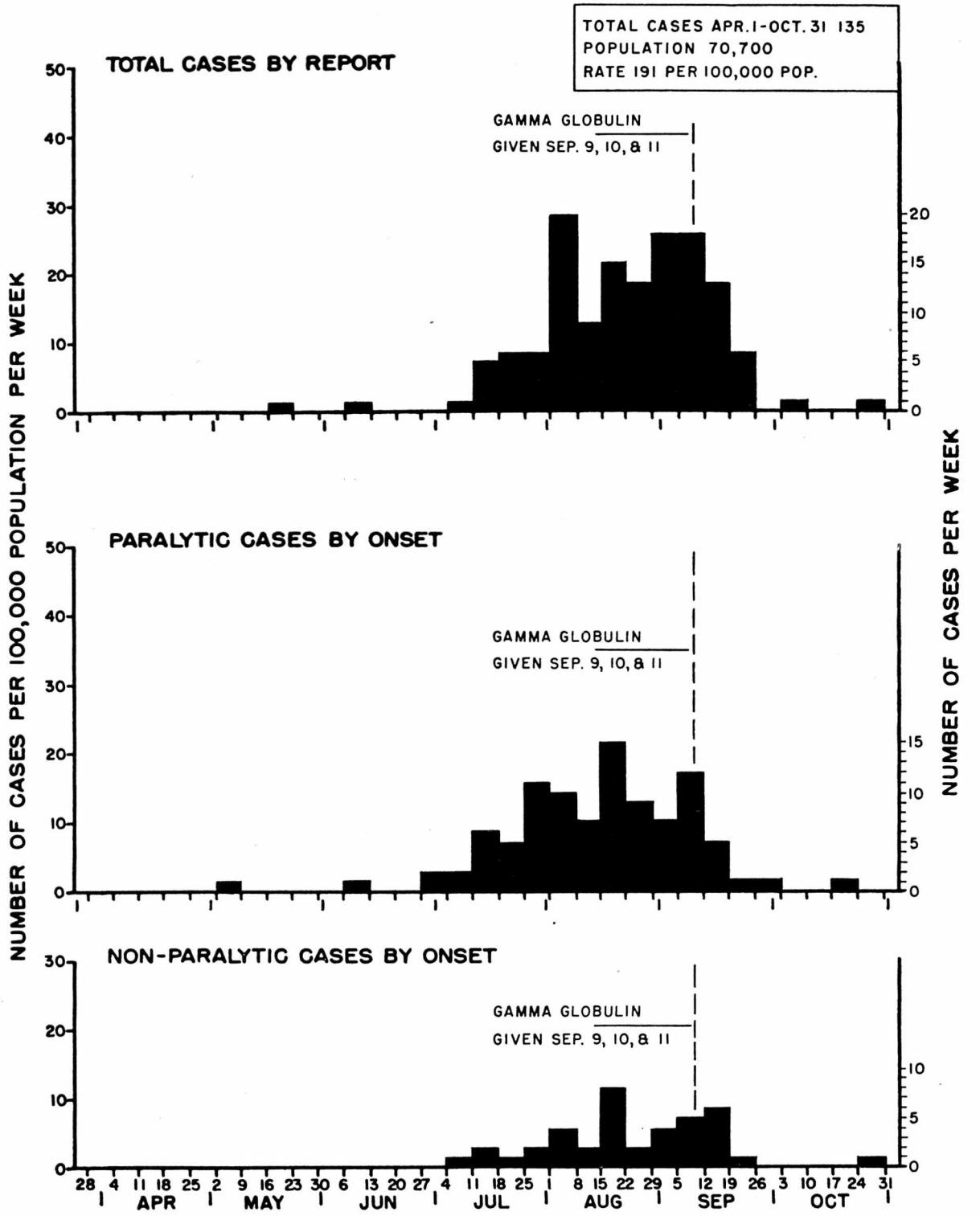


Figure 16B. Number of poliomyelitis cases per week, Stearns County, Minn., 1953, by week of onset, age group, and paralytic status.

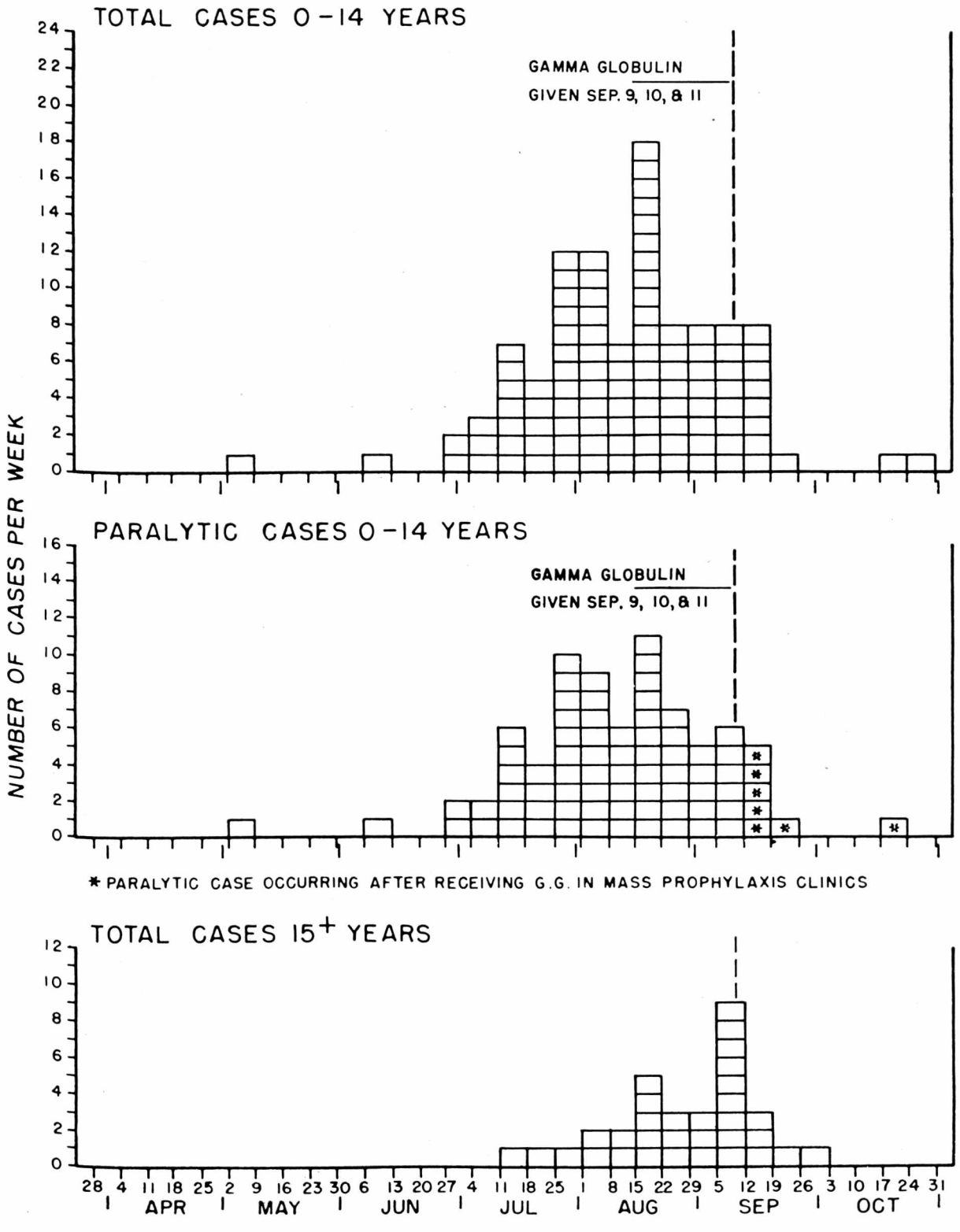


Figure 17A. Total weekly poliomyelitis incidence rates per 100,000 population, Benton County, Minn., 1953, by week of report, and paralytic status of cases, by week of onset.

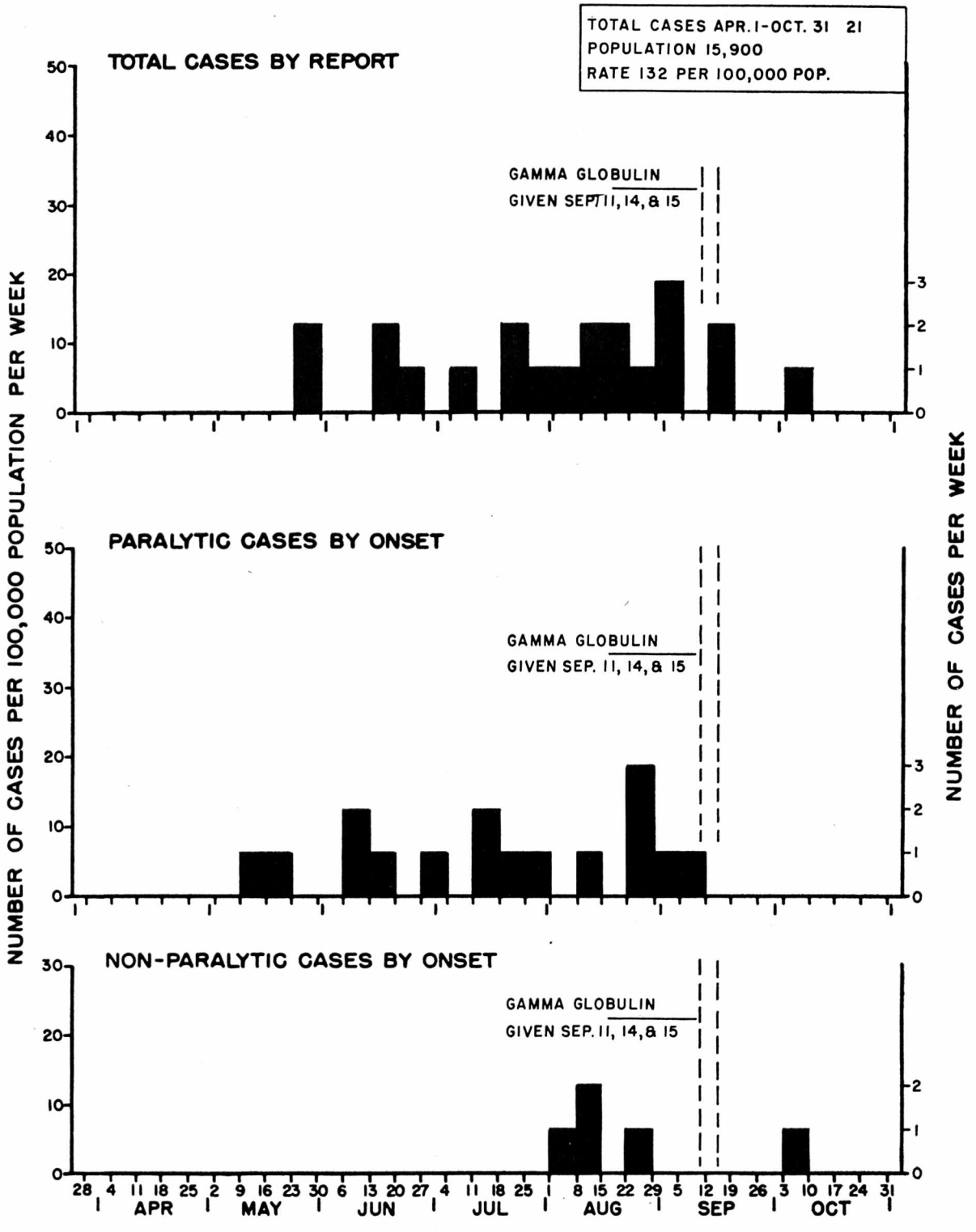


Figure 17B. Number of poliomyelitis cases per week, Benton County, Minn., 1953, by week of onset, age group, and paralytic status.

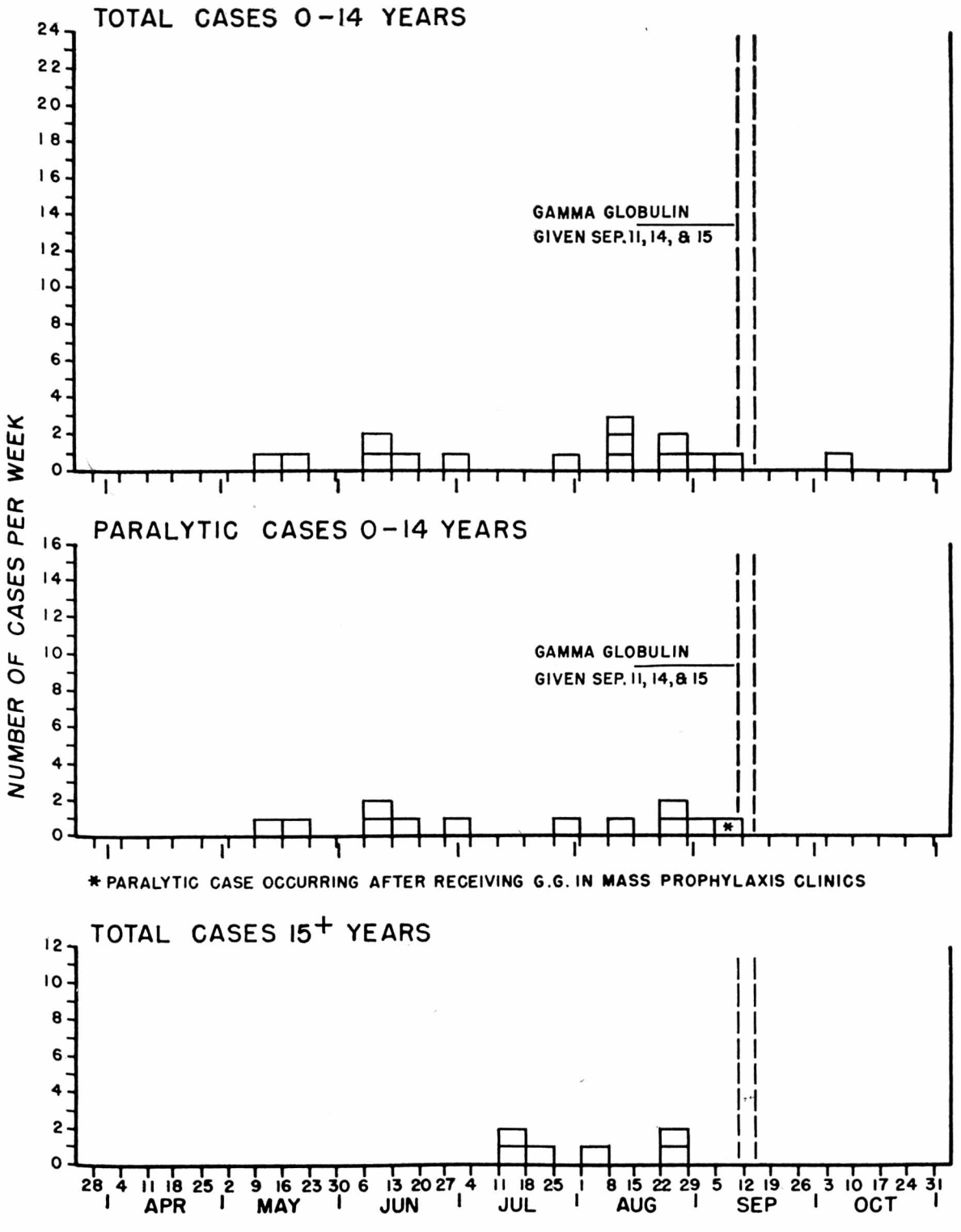
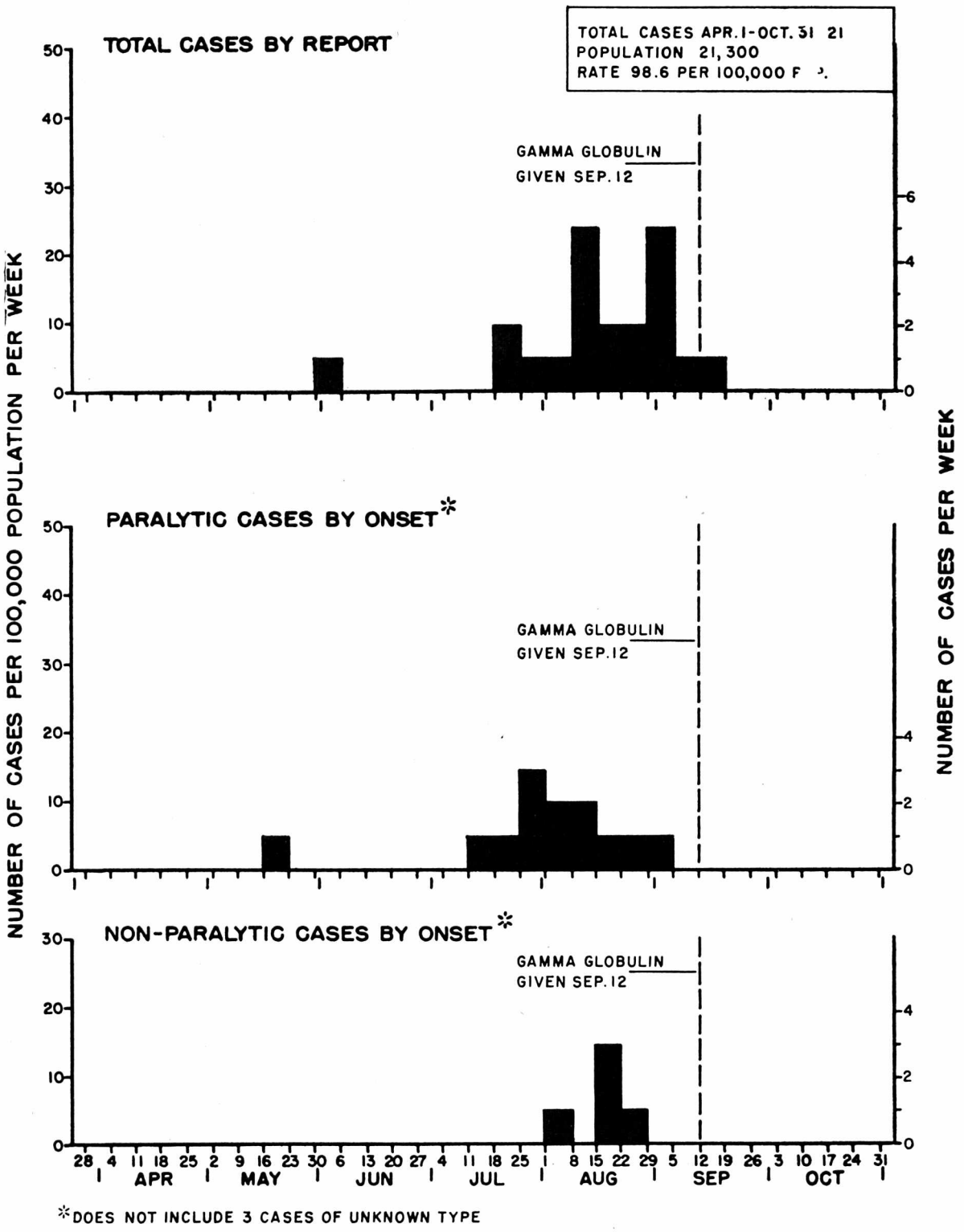


Figure 18A. Total weekly poliomyelitis incidence rates per 100,000 population, Woodford County, Ill., by week of report, and paralytic status of cases, by week of onset.




*DOES NOT INCLUDE 3 CASES OF UNKNOWN TYPE

Figure 18B. Number of poliomyelitis cases per week, Woodford County, Ill., 1953, by week of onset, age group, and paralytic status.

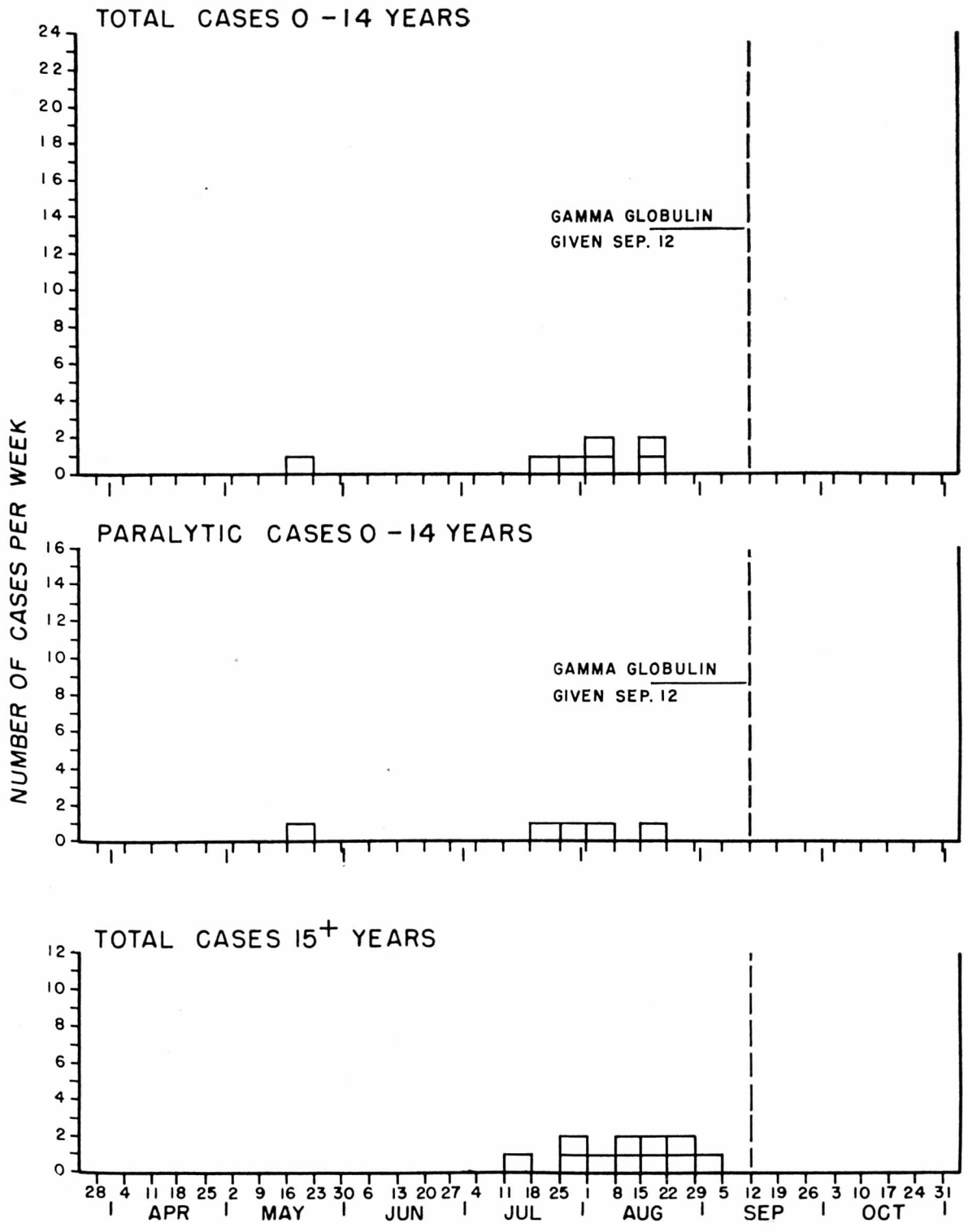


Figure 19A. Total weekly poliomyelitis incidence rates per 100,000 population, Polk County, Wis., 1953, by week of report, and paralytic status of cases, by week of onset.

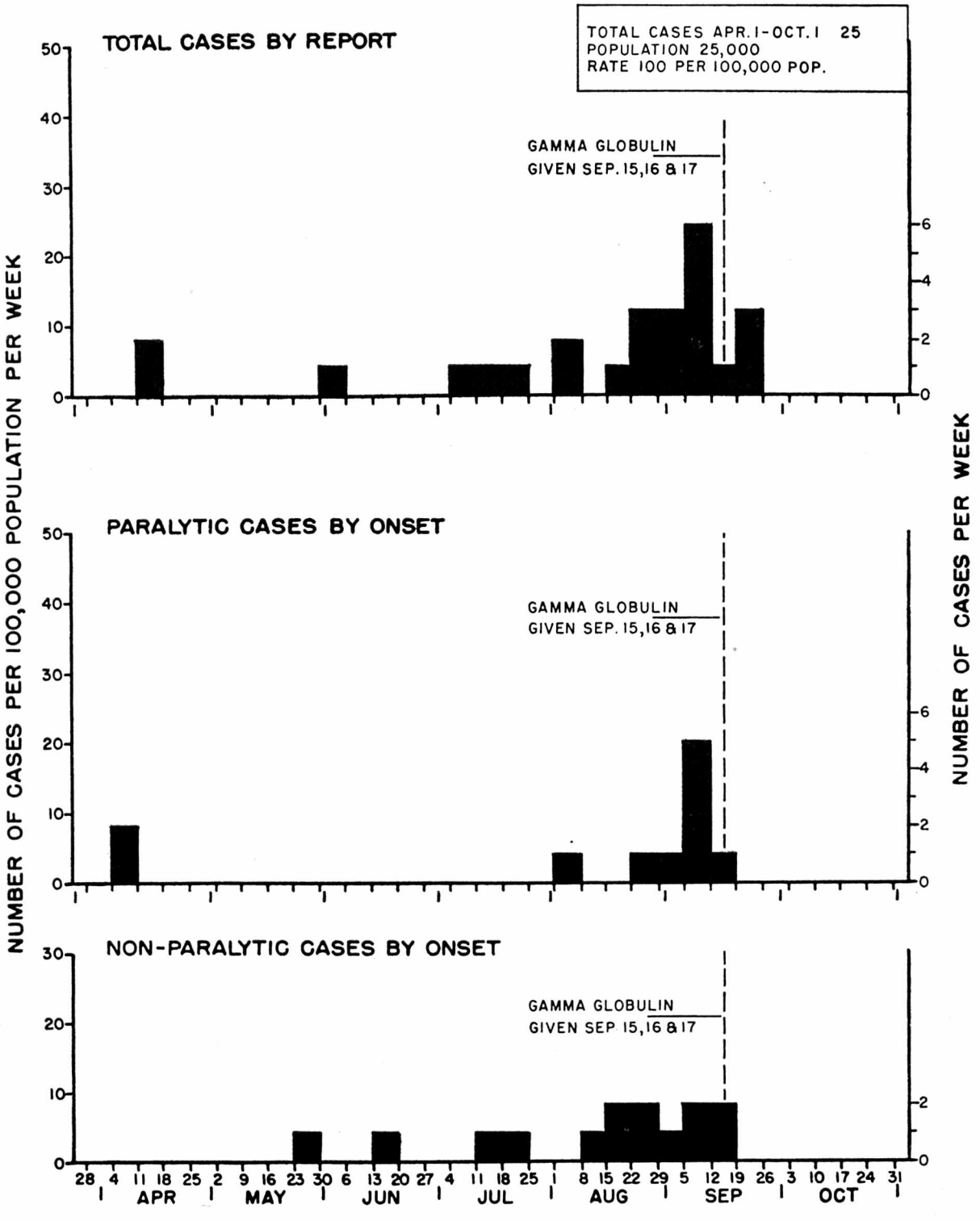
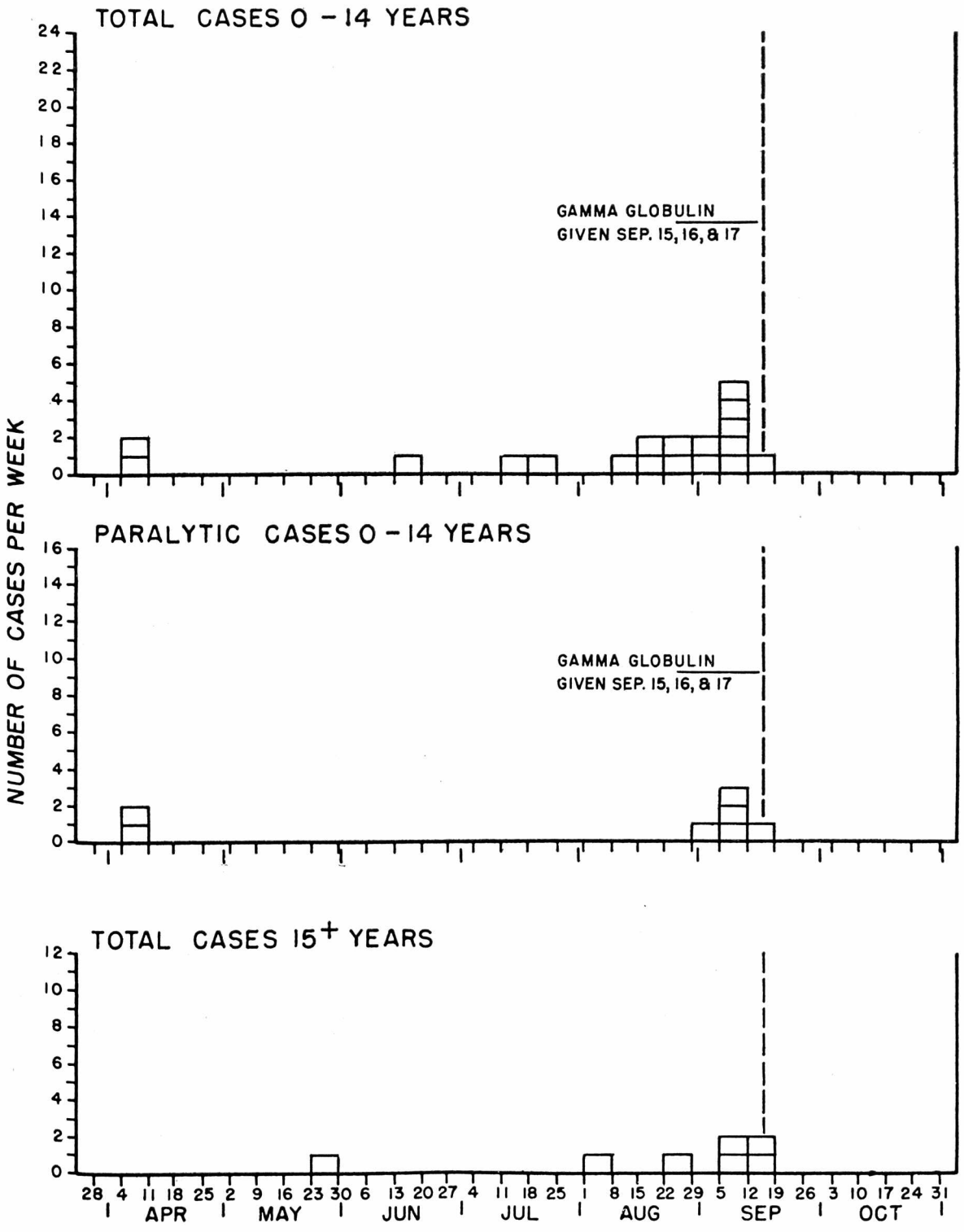


Figure 19B. Number of poliomyelitis cases per week, Polk County, Wis., 1953, by week of onset, age group and paralytic status.





294578—54——5

Figure 20A. Total weekly poliomyelitis incidence rates per 100,000 population, Meeker County, Minn., 1953, by week of report, and paralytic status of cases, by week of onset.

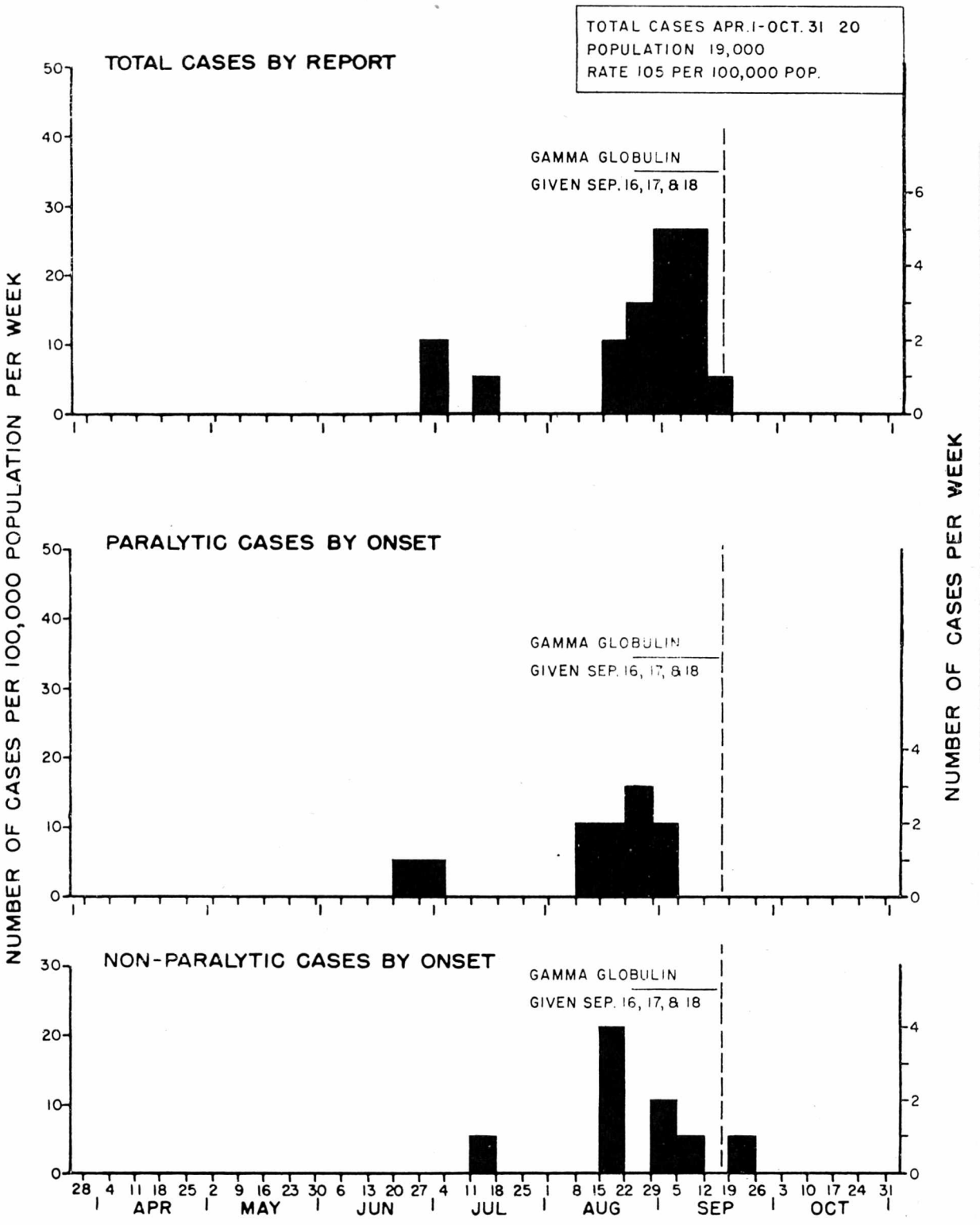


Figure 20B. Number of poliomyelitis cases per week, Meeker County, Minn., 1953, by week of onset, age group, and paralytic status.

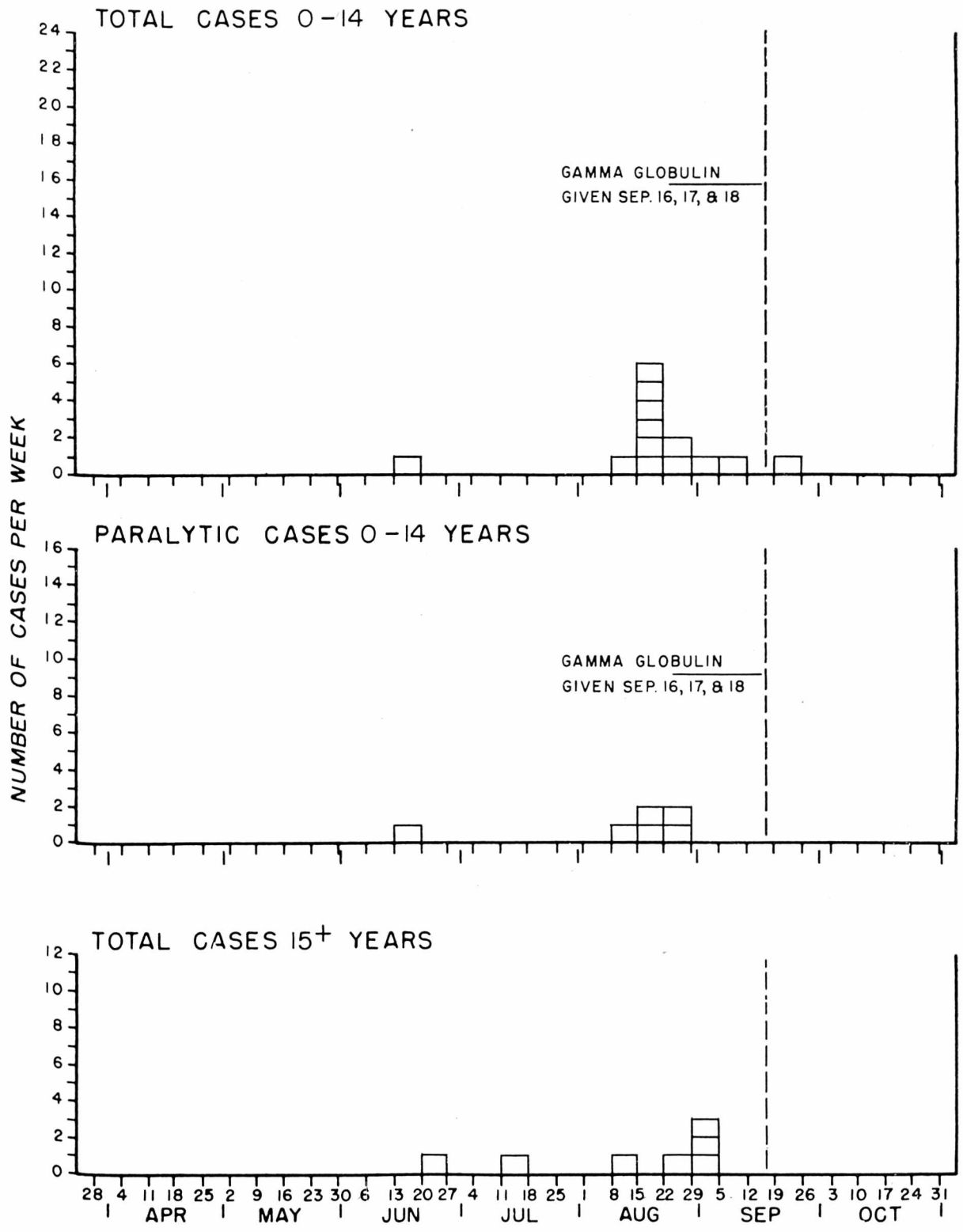


Figure 21A. Total weekly poliomyelitis incidence rates per 100,000 population, Randolph County, Mo., 1953, by week of report, and paralytic status of cases, by week of onset.

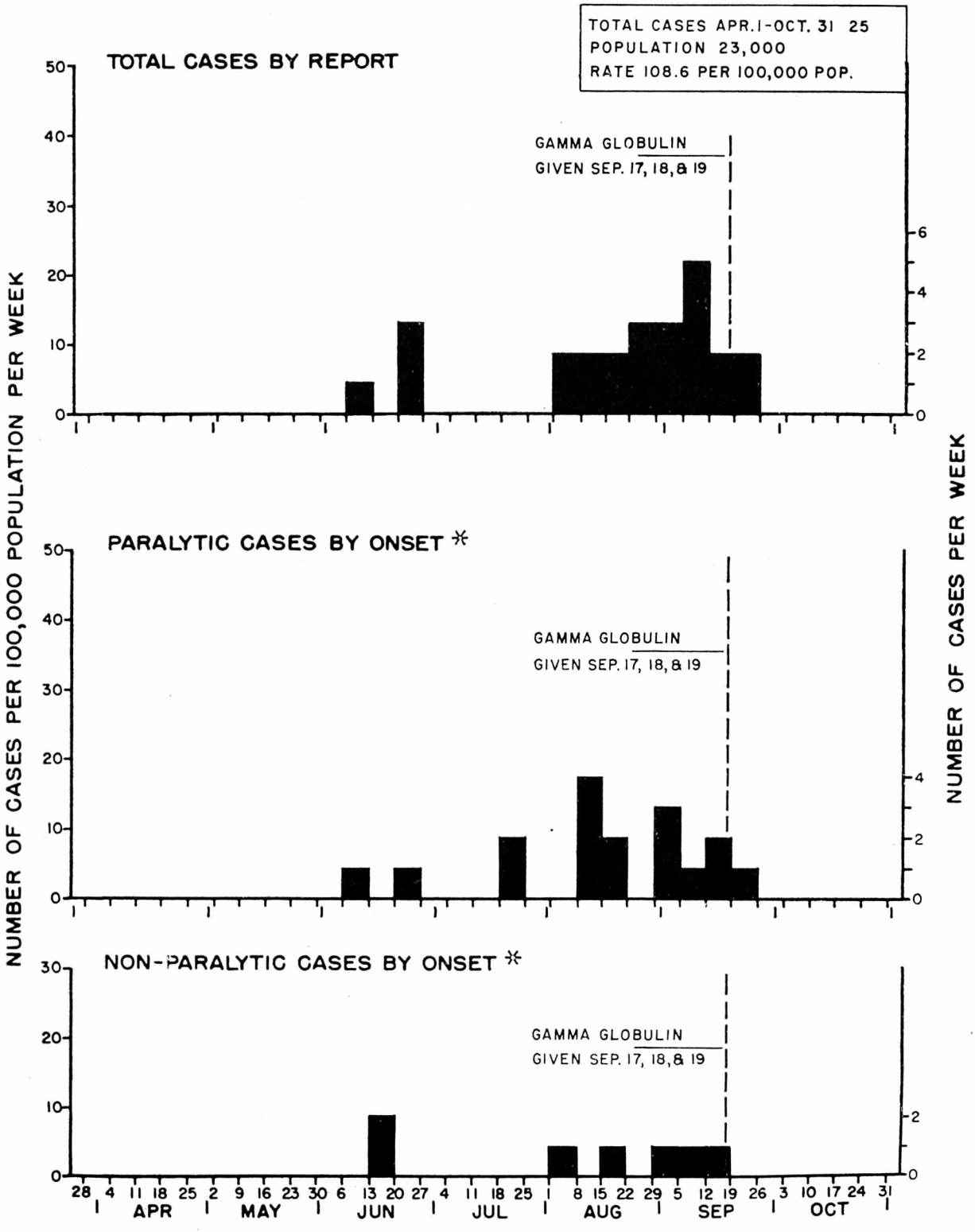


Figure 21B. Number of poliomyelitis cases per week, Randolph County, Mo., 1953, by week of onset, age group, and paralytic status.

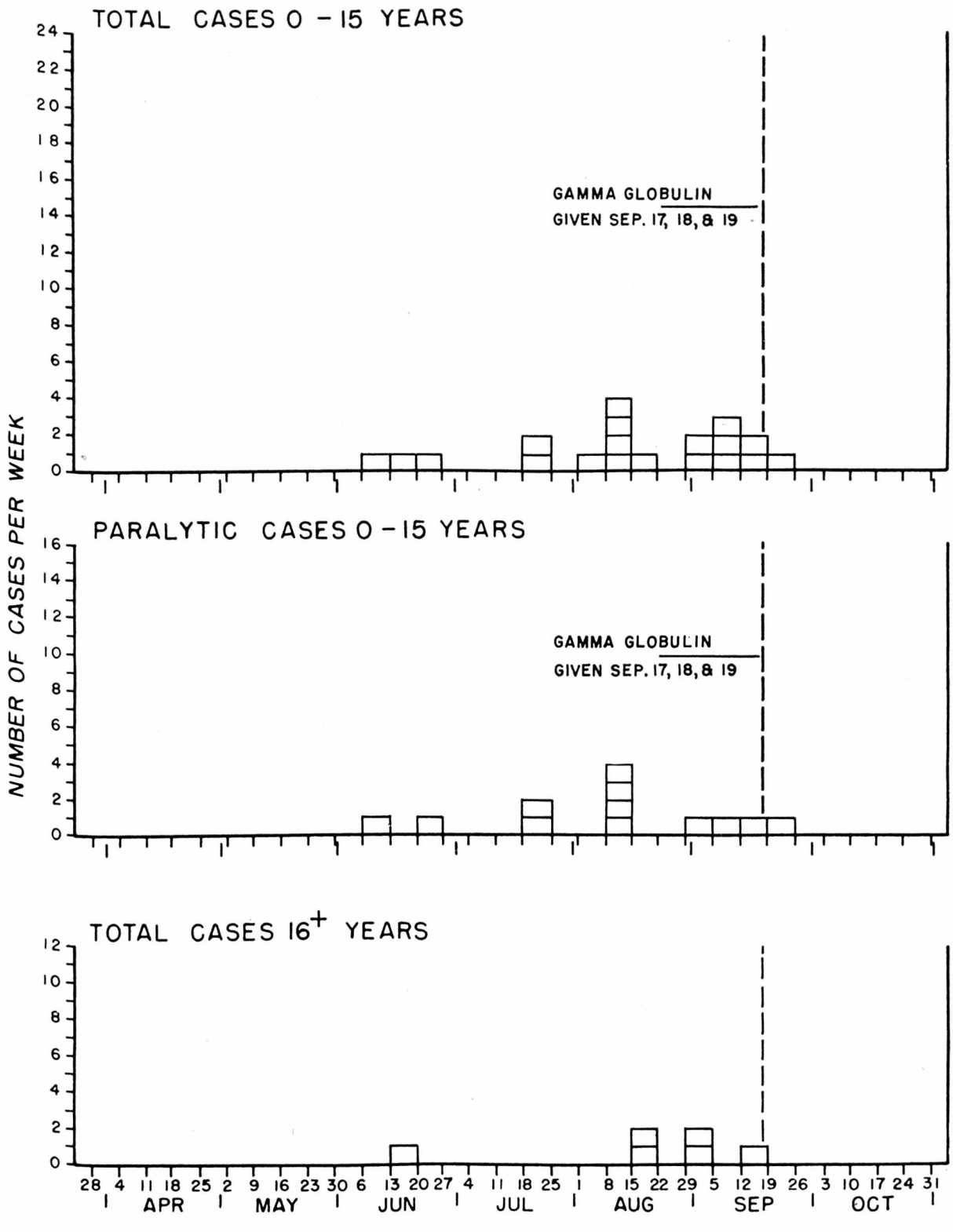


Figure 22A. Total weekly poliomyelitis incidence rates per 100,000 population, Monroe County, Fla., 1953, by week of report, and paralytic status of cases, by week of onset.

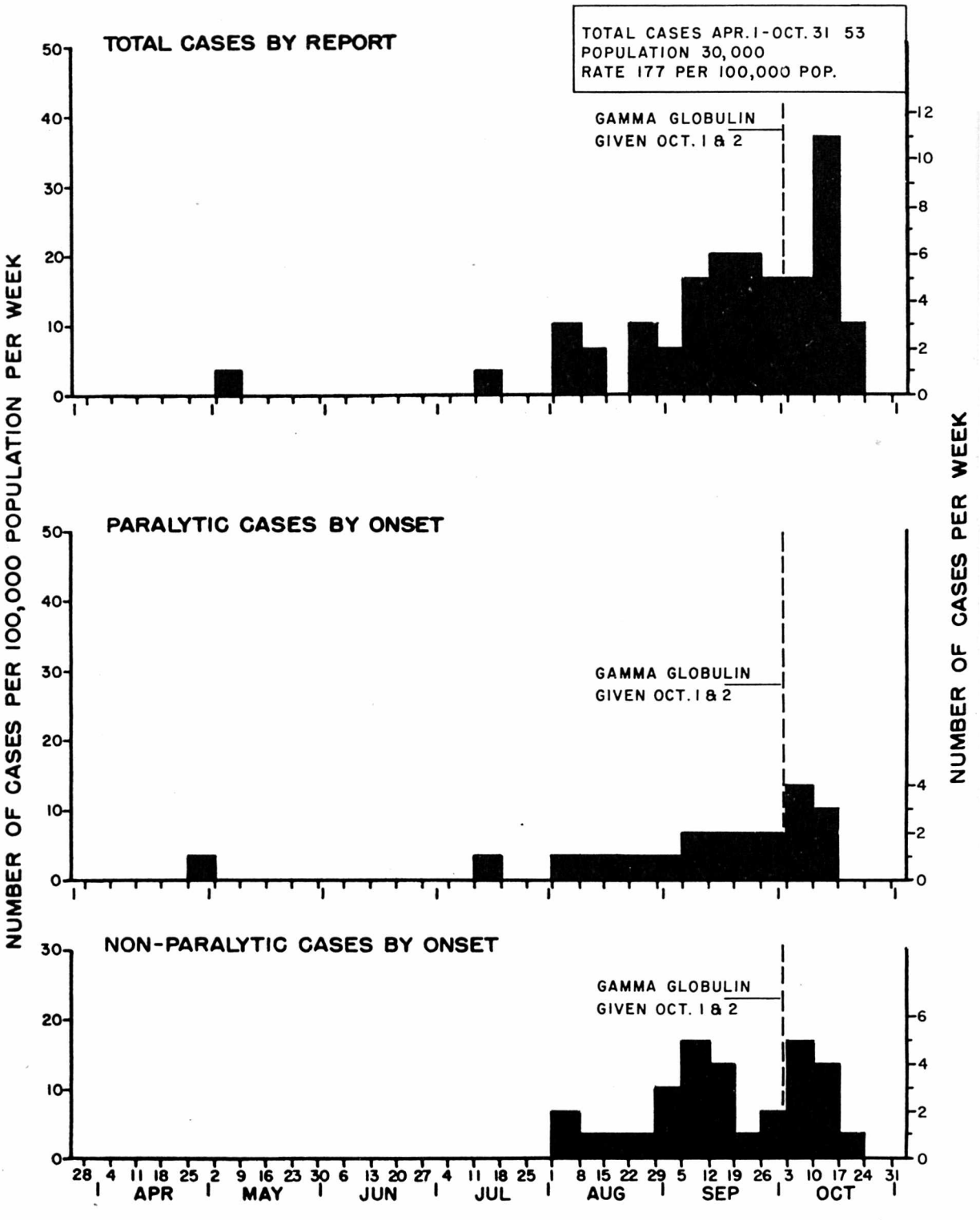


Figure 22B. Number of poliomyelitis cases per week, Monroe County, Fla., 1953, by week of onset, age group, and paralytic status.

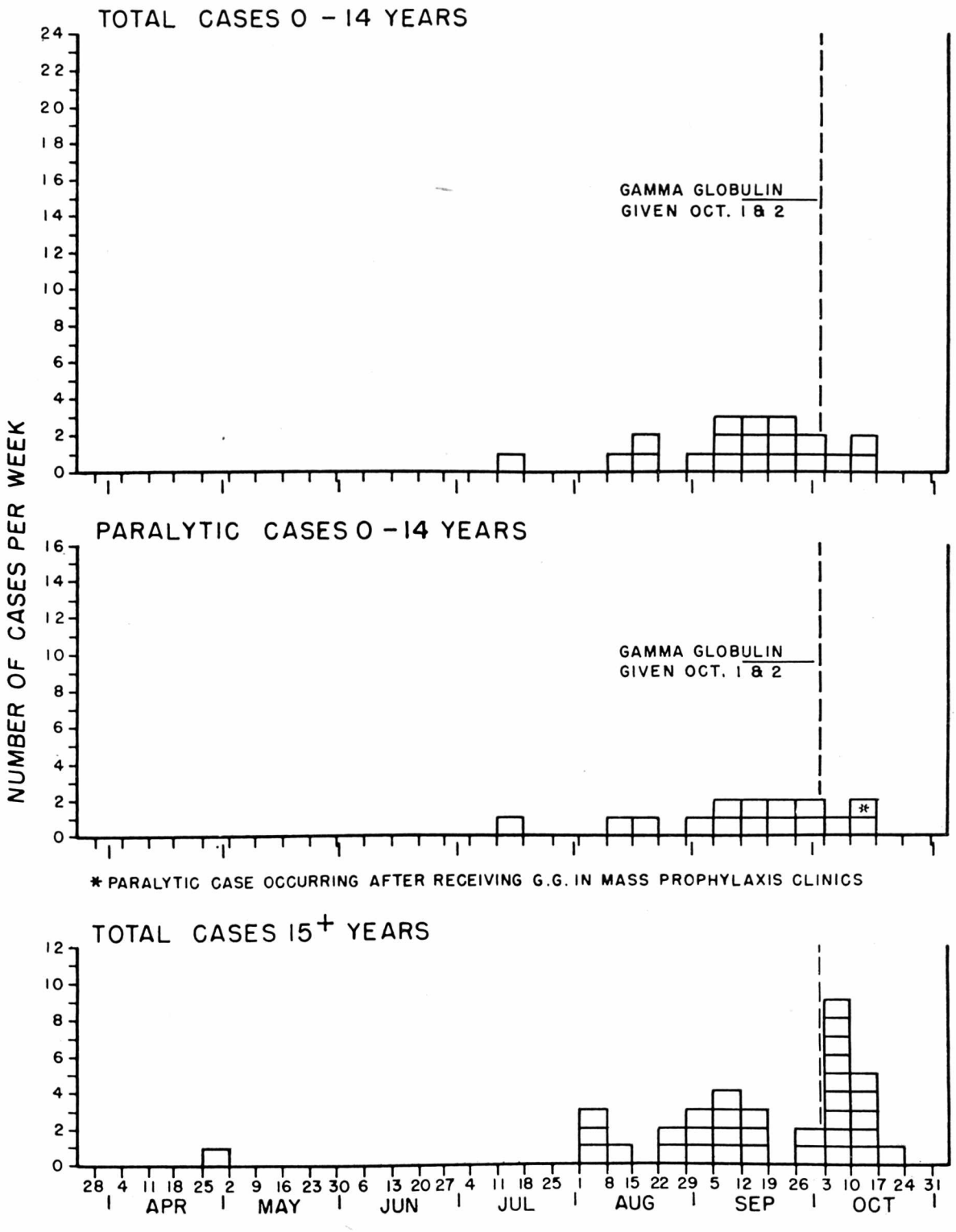


Figure 23A. Total weekly poliomyelitis incidence rates per 100,000 population, Shelby County, Ill., 1953, by week of report, and paralytic status of cases, by week of onset.

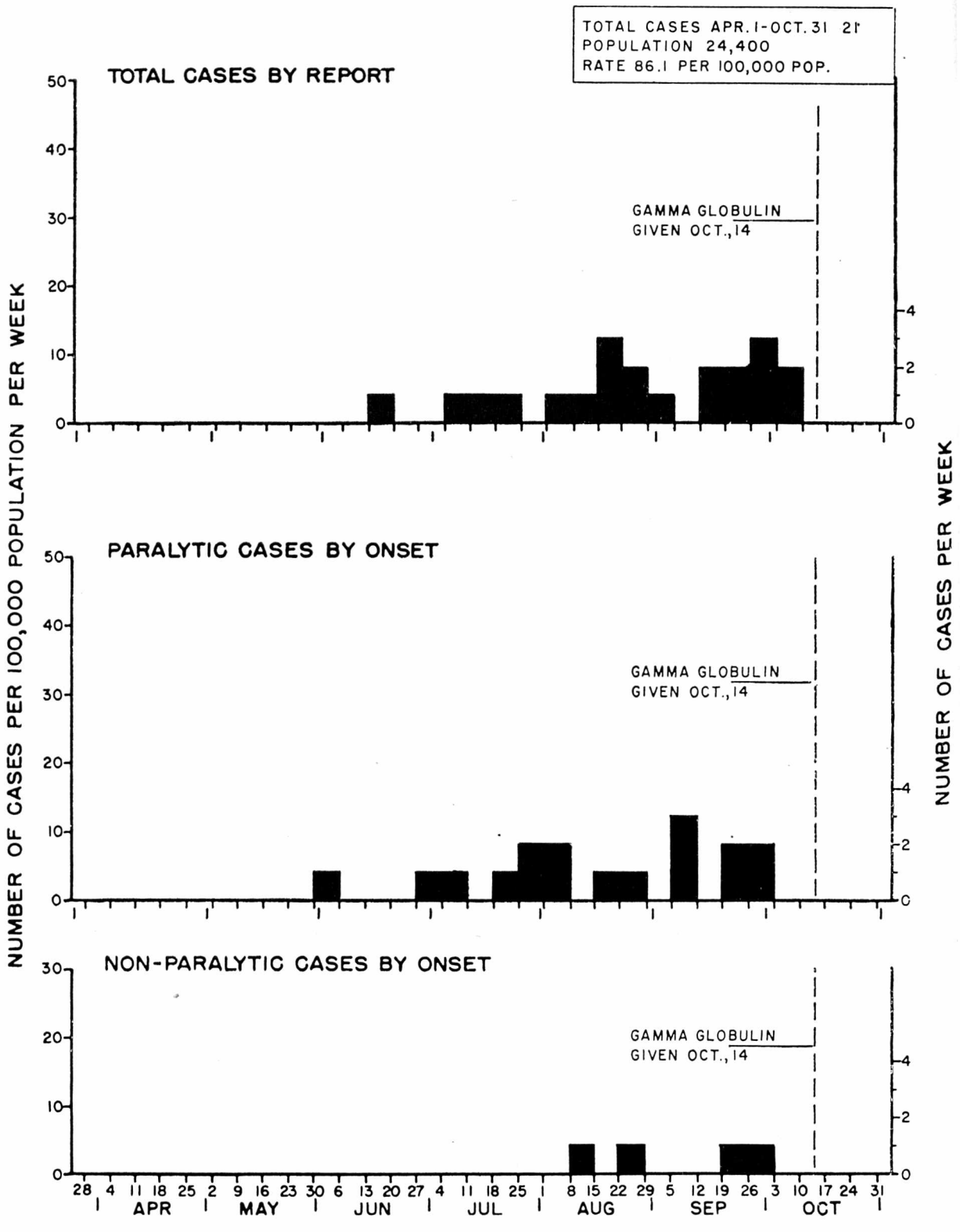
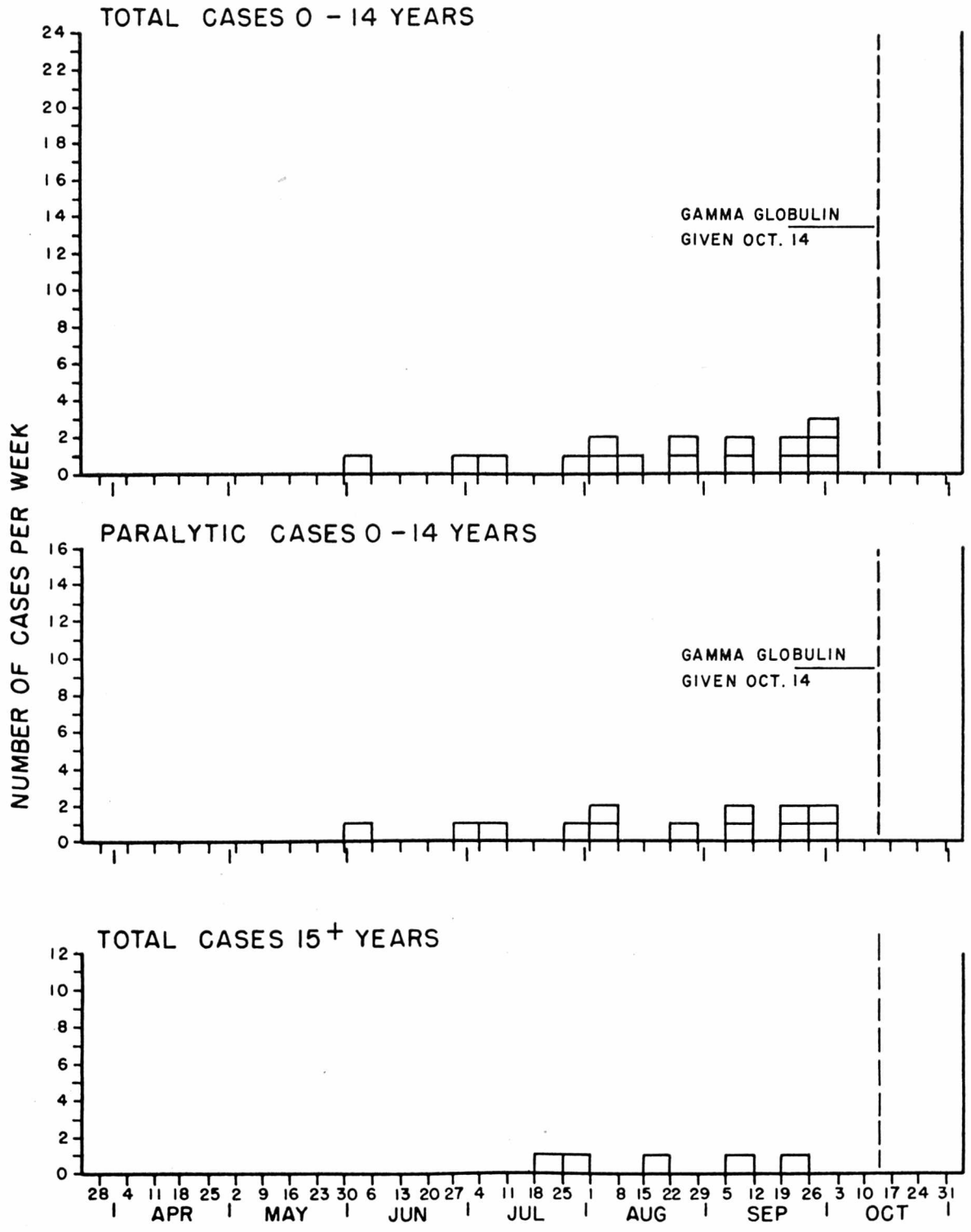


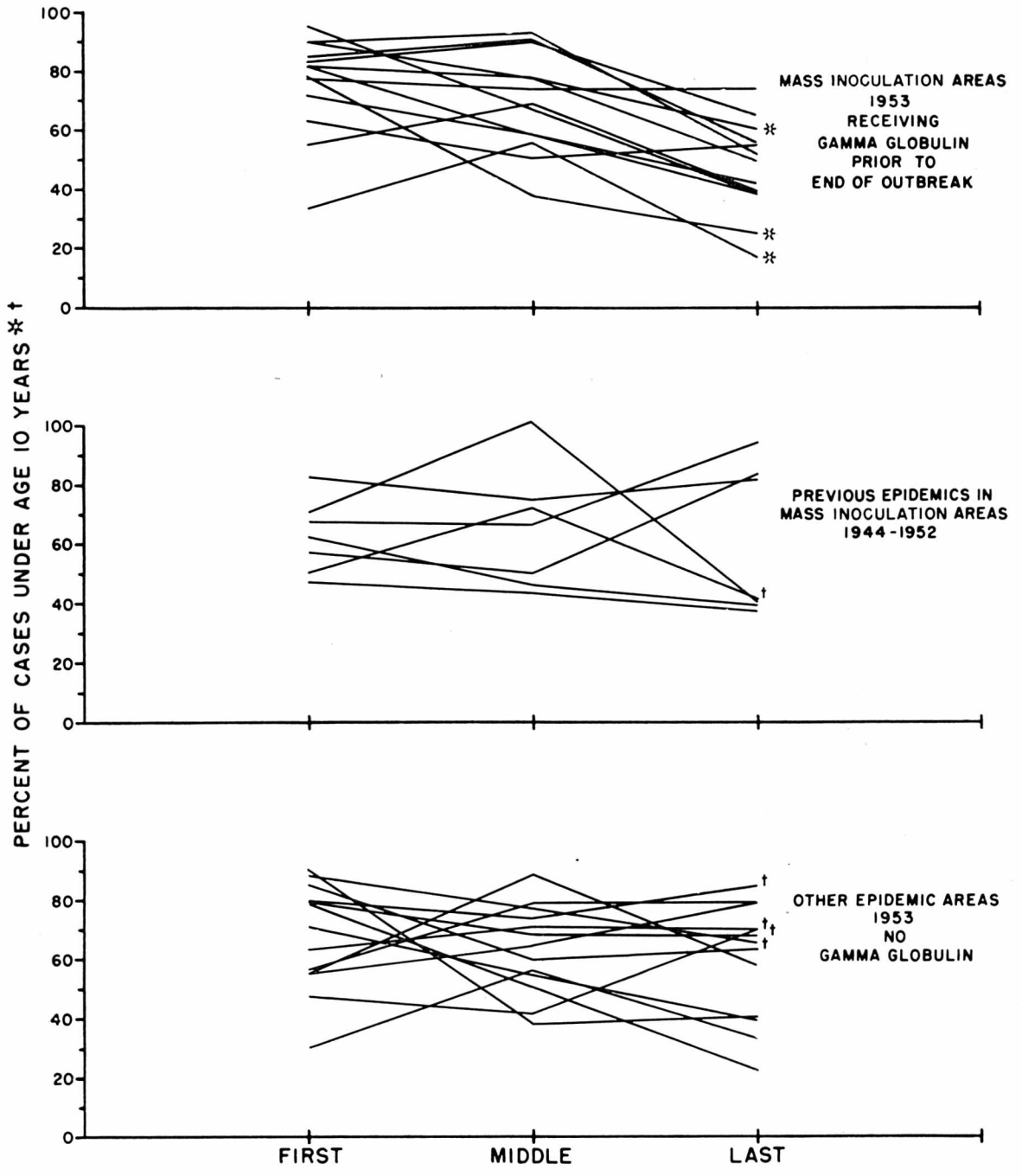
Figure 23B. Number of poliomyelitis cases per week, Shelby County, Ill., 1953, by week of report, and paralytic status of cases, by week of onset.





294578—54——6

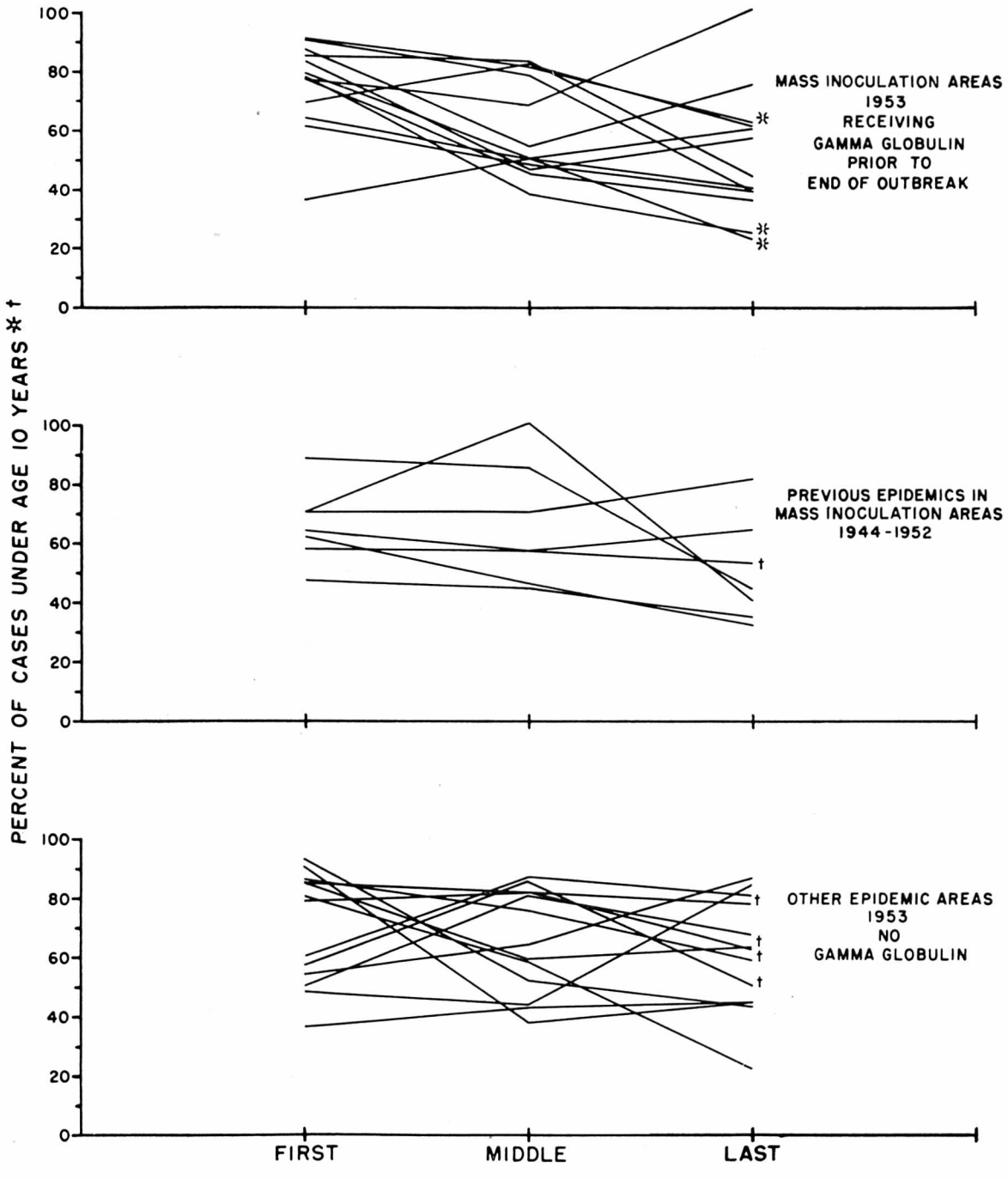
Figure 24. Age shifts during course of poliomyelitis epidemics (includes only epidemics of 25 or more cases). Epidemic divided into thirds by cases.




* AGE BREAK MADE AFTER 14 YEARS SINCE GAMMA GLOBULIN WAS GIVEN THROUGH THIS AGE GROUP

† AGE BREAK MADE AFTER 14 YEARS BECAUSE COUNTY IS COMPARABLE OR IDENTICAL WITH THOSE MARKED (*)

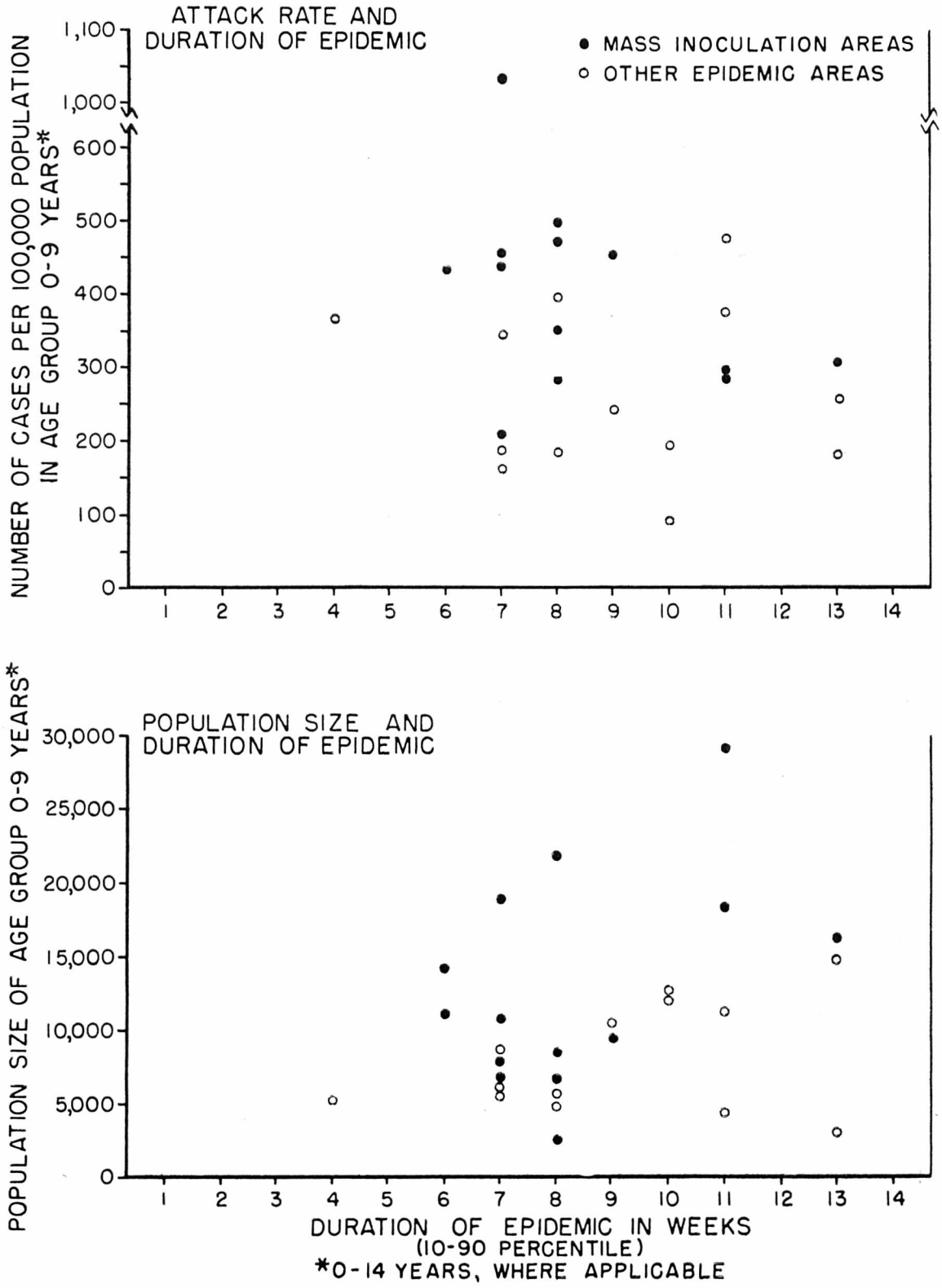
Figure 25. Age shifts during course of poliomyelitis epidemics (includes only epidemics of 25 or more cases). Epidemic divided into thirds by time.




* AGE BREAK MADE AFTER 14 YEARS SINCE GAMMA GLOBULIN WAS GIVEN THROUGH THIS AGE GROUP

† AGE BREAK MADE AFTER 14 YEARS BECAUSE COUNTY IS COMPARABLE OR IDENTICAL WITH THOSE MARKED (*)

Figure 26. Duration of the 1953 poliomyelitis epidemic in the 0–9 year age group (0–14 years, where applicable) in mass inoculation areas and in other epidemic areas (includes only epidemics of 25 or more cases).



# Evaluation of the Efficacy of Gamma Globulin in Household Contacts

The study of households in which multiple cases of poliomyelitis occurred was chosen as the most practical approach to the field evaluation of the efficacy of gamma globulin in familial and other intimate contacts. This became a nationwide undertaking. Several hundred individuals contributed to the collection and analysis of the data.

The purpose was to measure the degree to which gamma globulin modified the severity of paralysis since, as pointed out in chapter II, the practical usefulness of contact prophylaxis depends largely upon the existence of a definite modifying effect of gamma globulin. It was hoped that this extensive study would also yield some evidence regarding the existence of a preventive effect of gamma globulin, but it was recognized that in the absence of rigid controls definitive data on a preventive effect could not be expected.

The rationale of the study was based on the classical epidemiologic pattern of the familial aggregation of poliomyelitis. Since the early studies of Caverly, Wickman, and Frost, it has been universally recognized that multiple cases of clinically diagnosed poliomyelitis occur in households only infrequently, usually in less than 5 percent of instances. Furthermore, when multiple cases do arise, the interval between cases is usually short, 5 days or less in approximately 60 percent of instances, between 6 and 12 days in approximately 30 percent, and longer than 12 days in about 10 percent. A summary of several previous studies is presented in table 20.

The study of multiple-case households made possible the identification of three groups of cases: (*a*) the index cases, in none of which gamma globulin was given before onset; (*b*) subsequent cases in which gamma globulin was not given; and (*c*) subsequent cases in which it was given.

**Table 20. Interval between onsets of index and subsequent cases of poliomyelitis in multiple-case households collated from various series by Dr. William Clark**

| Interval (days) | Number and percent of subsequent cases | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sweden (1905) [1] | | New York City (1916) [2] | | Collected series [3] (1910–1924) [4] | | Los Angeles (1943) [5] | | Minnesota (1946) [6] | | New York State (1950) [7] | | Utah-Iowa (1951–52) [8] | |
| | Number | Percent | Number | Percent | Number | Percent | Number | Percent | Number | Percent | Number | Percent | Number | Percent |
| 0–5 | 81 | 63. 8 | 285 | 72. 1 | 77 | 55. 0 | 22 | 57. 9 | 122 | 62. 2 | 79 | 57. 2 | 19 | 59. 3 |
| 6–12 | 34 | 26. 8 | 92 | 23. 3 | 44 | 31. 4 | 14 | 36. 8 | 60 | 30. 6 | 35 | 25. 4 | 11 | 34. 4 |
| 13–30 | 12 | 9. 4 | 18 | 4. 6 | 19 | 13. 6 | 2 | 5. 3 | 14 | 7. 2 | 24 | 17. 4 | 2 | 6. 3 |
| Total | 127 | 100. 0 | 395 | 100. 0 | 140 | 100. 0 | 38 | 100. 0 | 196 | 100. 0 | 138 | 100. 0 | 32 | 100. 0 |

[1] Lavinder, C. H., Freeman, A. W., and Frost, W. H.: Epidemiologic studies of poliomyelitis in New York City and the northeastern United States during the year 1916; United States Public Health Service, Public Health Bulletin No. 91. Government Printing Office, Washington, D. C., 1918.

[2] Ibid.

[3] To 25-day interval only.

[4] Aycock, W. L. and Eaton, P.: American Journal of Hygiene, 5:724 (1925). Data are included for New York State, 1921–24; Detroit, Mich., 1924; Missoula, Mont., 1924; Massachusetts, 1921–23; Vermont, 1910–24.

[5] Swartout, O. H. and Frank, W. P.: J. A. M. A. 125:488 (1944).

[6] Data furnished by Dr. Gaylord Anderson, University of Minnesota School of Public Health.

[7] Data furnished by Dr. R. F. Korns, New York State Department of Health.

[8] Data furnished by Dr. William McD. Hammon, University of Pittsburgh School of Public Health.

A comparison of the severity of the index cases with that of the subsequent cases which received gamma globulin was not considered to be a valid one. There was reason to believe that index cases would tend to be somewhat more severe than subsequent cases on the grounds that the existence of the index case in a family would draw attention to some mild cases that otherwise would have been missed.

A comparison, however, limited to the subsequent cases themselves according to whether or not gamma globulin was administered, was considered to be more valid. While these two groups of subsequent cases could not be considered strictly comparable, they were considered to provide the best attainable comparison short of a rigidly controlled study.

Two factors, age and interval between onset of index and subsequent cases, were recognized as possible sources of bias. A variation in the severity of disease by age could be expected on the basis of the known increase of case fatality rates among adults. Furthermore, subsequent cases tend to be older than primary or index cases. The data, therefore, had to be examined for the effects of this age factor.

The effect of the interval between onset of index and subsequent case also was recognized as a possibly important factor. Subsequent cases might tend to become milder as the interval increased, because the later cases presumably represent individuals coming down after longer incubation periods. Some unpublished observations from the laboratory (Sabin) and from the field (Leftwich and Chapman) supported this concept. Therefore, a large group of cases was necessary in this study in order to determine with reasonable reliability the extent of the effect of these several factors and to give statistical stability to a complex analysis.

It was reasoned that only a few of the 60 percent of subsequent cases coming down within 5 days of the index case would receive gamma globulin because a lag of 3 to 5 days could be anticipated between the onset of the index case and the time of diagnosis of the subsequent case. A much larger proportion of the 30 percent of cases developing the disease from 6 to 12 days after the index case would receive gamma globulin, and these would receive it mostly within 7 days of onset. A comparison of this group of cases with the early group should provide a measure of the modifying effect of gamma globulin.

The preventive effect of gamma globulin might be apparent through changes in the observed proportion of subsequent cases developing more than 12 days after the index cases. Approximately 10 percent of subsequent cases could be expected in this group. From table 20, it may be seen that this proportion varied from 4.6 percent to 17.4 percent. With such variability it was evident that the possible preventive effect of gamma globulin would be observable in this type of study only if: (*a*) a very large series were studied; (*b*) gamma globulin were given very consistently to most family contacts; and (*c*) gamma globulin possessed a marked preventive effect.

## Description of the Data

During the period June 1 to October 31, a total of 27,600 cases of poliomyelitis were reported from the 41 States, the District of Columbia, and 3 cities participating in the program. From these areas, a total of 830 multiple-case household records, consisting of 1,828 individual patients, were submitted to the National Evaluation Center. These comprise 3.0 percent of the total reported cases from the study area, and this frequency suggests that a large majority of the total multiple-case households have been included in the study.

In this group, 81 household records (9.8 percent) were incomplete for some important item of information and therefore were deleted. The distribution of these deletions by States is shown in table 21. Thus, case records from 749 households were available for analysis.

Table 21 lists the source of these records by State, and shows the distribution of households according to the number of subsequent cases that occurred. Most of these households had only 2 cases but occasionally as many as 5 individuals were involved. The 1,654 complete case records consist of 749 index cases, 80 co-index cases, 8 pre-index primary cases, and 817 subsequent cases. Further analyses were limited to this last group of 817 cases.

In table 22, the number of subsequent pa-

tients receiving gamma globulin, before onset, or on or after onset, is shown by monthly intervals. As the poliomyelitis season progressed the percentage of patients receiving gamma globulin before onset increased from less than 10 percent to almost 50 percent. Over the entire season 278 of the 817 subsequent cases, or 34 percent, received gamma globulin before onset, and 137, or 16.8 percent, received it on or after onset. Slightly less than half of the subsequent cases did not receive gamma globulin. These represent in a large measure the subsequent cases having onsets shortly after the index cases.

**Table 21. Multiple-case household records by participating States**

| State | Complete records | | | | | | | | | Incomplete records [1] | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Number of multiple case households | Number cases per household | | | | Index cases | Subsequent cases | Prior cases | Total cases | Number of multiple case households | Total cases |
| | | 2 | 3 | 4 | 5 | | | | | | |
| Alabama | 27 | 23 | 4 | 0 | 0 | 27 | 31 | 0 | 58 | 1 | 2 |
| Arkansas | 3 | 3 | 0 | 0 | 0 | 3 | 3 | 0 | 6 | 0 | 0 |
| California | 55 | 50 | 5 | 0 | 0 | 55 | 60 | 0 | 115 | 3 | 6 |
| Colorado | 3 | 2 | 1 | 0 | 0 | 3 | 4 | 0 | 7 | 3 | 9 |
| Connecticut | 16 | 14 | 2 | 0 | 0 | 16 | 18 | 0 | 34 | 1 | 2 |
| Delaware | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Washington, D. C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Florida | 21 | 19 | 2 | 0 | 0 | 21 | 23 | 0 | 44 | 2 | 4 |
| Georgia | 5 | 4 | 1 | 0 | 0 | 5 | 6 | 0 | 11 | 0 | 0 |
| Idaho | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 2 | 0 | 0 |
| Illinois | 53 | 45 | 7 | 1 | 0 | 53 | 62 | 0 | 115 | 1 | 3 |
| Chicago | 10 | 7 | 2 | 1 | 0 | 10 | 14 | 0 | 24 | 0 | 0 |
| Iowa | 21 | 14 | 4 | 2 | 1 | 21 | 32 | 0 | 53 | 2 | 4 |
| Kansas | 9 | 5 | 1 | 2 | 1 | 9 | 17 | 0 | 26 | 0 | 0 |
| Kentucky | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 2 | 0 | 0 |
| Louisiana | 18 | 13 | 3 | 1 | 1 | 18 | 26 | 0 | 44 | 0 | 0 |
| Maine | 12 | 11 | 1 | 0 | 0 | 12 | 13 | 0 | 25 | 0 | 0 |
| Maryland | 20 | 15 | 4 | 1 | 0 | 20 | 23 | 3 | 46 | 0 | 0 |
| Massachusetts | 23 | 20 | 3 | 0 | 0 | 23 | 26 | 0 | 49 | 1 | 2 |
| Michigan | 34 | 28 | 6 | 0 | 0 | 34 | 40 | 0 | 74 | 2 | 4 |
| Minnesota | 73 | 67 | 6 | 0 | 0 | 73 | 79 | 0 | 152 | 11 | 24 |
| Mississippi | 4 | 3 | 1 | 0 | 0 | 4 | 5 | 0 | 9 | 1 | 2 |
| Missouri | 47 | 36 | 9 | 1 | 1 | 47 | 60 | 1 | 108 | 0 | 0 |
| Nebraska | 7 | 7 | 0 | 0 | 0 | 7 | 7 | 0 | 14 | 1 | 2 |
| Nevada | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New Hampshire | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New York | 73 | 62 | 9 | 1 | 1 | 73 | 87 | 0 | 160 | 1 | 2 |
| New York City | 8 | 7 | 1 | 0 | 0 | 8 | 9 | 0 | 17 | 0 | 0 |
| North Carolina | 45 | 34 | 9 | 2 | 0 | 45 | 57 | 1 | 103 | 0 | 0 |
| North Dakota | 3 | 2 | 1 | 0 | 0 | 3 | 4 | 0 | 7 | 1 | 2 |
| Ohio | 30 | 29 | 1 | 0 | 0 | 30 | 30 | 1 | 61 | 8 | 16 |
| Oklahoma | 4 | 2 | 2 | 0 | 0 | 4 | 6 | 0 | 10 | 0 | 0 |
| Oregon | 4 | 3 | 1 | 0 | 0 | 4 | 5 | 0 | 9 | 0 | 0 |
| Pennsylvania | 32 | 27 | 5 | 0 | 0 | 32 | 37 | 0 | 69 | 5 | 12 |
| Rhode Island | 14 | 12 | 1 | 0 | 1 | 14 | 18 | 0 | 32 | 0 | 0 |
| South Carolina | 5 | 5 | 0 | 0 | 0 | 5 | 5 | 0 | 10 | 0 | 0 |
| Tennessee | 22 | 15 | 7 | 0 | 0 | 22 | 28 | 1 | 51 | 0 | 0 |
| Texas | 12 | 11 | 0 | 1 | 0 | 12 | 14 | 0 | 26 | 2 | 4 |
| Utah | 10 | 7 | 3 | 0 | 0 | 10 | 12 | 1 | 23 | 0 | 0 |
| Vermont | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Virginia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 29 | 62 |
| Washington | 20 | 12 | 6 | 2 | 0 | 20 | 30 | 0 | 50 | 1 | 2 |
| West Virginia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 10 |
| Wisconsin | 4 | 4 | 0 | 0 | 0 | 4 | 4 | 0 | 8 | 0 | 0 |
| Totals | 749 | 620 | 108 | 15 | 6 | 749 | 897 | 8 | 1,654 | 81 | 174 |

[1] Incomplete records include those where muscle evaluations were refused, or could not be performed for other reasons, where some important item of information could not be accurately obtained, and where the records were received too late for inclusion in the detailed statistical analysis.

**Table 22. Distribution of subsequent cases occurring 1 day or more after index case by month of onset and gamma globulin status (80 co-index cases not included)**

| Month | Number of subsequent cases | | | | |
|---|---|---|---|---|---|
| | Total | Receiving gamma globulin before onset | | Receiving gamma globulin on or after onset | Not receiving gamma globulin |
| | | *Number* | *Percent* | | |
| April | 1 | 0 | 0. 0 | 0 | 1 |
| May | 8 | 2 | 25. 0 | 1 | 5 |
| June | 64 | 6 | 9. 4 | 9 | 49 |
| July | 198 | 65 | 32. 8 | 34 | 99 |
| August | 297 | 101 | 34. 0 | 49 | 147 |
| September | 188 | 74 | 39. 4 | 36 | 78 |
| October | 61 | 30 | 49. 2 | 8 | 23 |
| Total | 817 | 278 | 34. 0 | 137 | 402 |

In planning the analysis of these records for the possible effect of gamma globulin, careful consideration was given to a number of factors that might introduce bias or undesirable variability. For example, cases occurring in the nonwhite population would be drawn from such a different socioeconomic group that separate analysis was deemed warranted. Actually less than 5 percent of cases occurred in nonwhites. This reflected the relatively low incidence of poliomyelitis in the south and in the large cities during 1953.

Another factor was age. Only 4.1 percent of cases were under 1 year of age. Muscle evaluations in this group, before the toddling stage, are difficult and much less accurate than the relatively precise measurements that can be made at later ages. Therefore, cases under 1 year of age were excluded from the analysis.

A different problem was encountered in considering cases 30 years of age and older. A basic assumption of the study was that gamma globulin was freely available for household contacts. This was quite generally true up to the age of 30 years because almost all States followed the recommendations of the National Allocation Authority. In only a few areas, and late in the season, was gamma globulin available for contacts 30 years of age or older, other than pregnant women. Therefore, the inclusion of such older cases in the study would have introduced a possibly serious bias because cases in this age group are known to have a higher case fatality, and those deaths would have fallen selectively into the no gamma globulin group.

These three factors of bias were eliminated by the exclusion from the total of 817 subsequent cases of 37 cases among nonwhites of all ages, 32 cases among whites under 1 year of age and 82 cases among whites 30 years of age and older. These exclusions reduced the number of cases in the analysis to 666.

A clinical classification of these cases into paralytic, nonparalytic, and suspect cases was available from the "7- to 14-day" evaluation. It should be emphasized, however, that this evaluation was only qualitative in nature and was made primarily as an initial screening for the purpose of eliminating reported cases in which the diagnosis was revoked during the acute illness.

Another classification of these cases was available from the 50- to 70-day muscle evaluations. These were made for the purpose of determining the severity of paralysis after the disease had become reasonably stabilized. These evaluations were quantitative in nature and were based on the consistent records of physical therapists trained to use uniform methods.

In the examination of the records of the 50- to 70-day evaluations a problem was encountered in determining the paralytic status of very mild cases. There were 33 cases in which the records revealed muscle involvement of less than 0.5 percent. Among these were 10 cases in which the only involvement recorded was a

deviation of the palate. In half of these "enlarged tonsils" was recorded, which would make it difficult to decide whether or not the palate was minimally involved. There were 4 cases where minimum involvement of a muscle was recorded with the note "probably normal." A clinical review of these 33 records indicated that 7 could have been classified as paralytic poliomyelitis on the grounds of definite involvement of small muscles. Of these, five were mild bulbar cases. In view of these findings it appeared to be clinically reasonable to choose a muscle involvement of 0.5 percent as an arbitrary criterion for defining a paralytic case for the purposes of this study.

A comparison of the 666 subsequent cases according to the two classifications is shown in table 23. According to the 7- to 14-day evaluation, approximately half the cases, 50.8 percent, were classified as paralytic and the remainder as nonparalytic or suspect. According to the 50- to 70-day evaluation, however, almost three-fourths of the cases, 73.6 percent, were found to be paralytic. It is of interest that 107 nonparalytic and 74 suspect cases by the early classification were found actually to be paralytic at the later evaluation. On the other hand, only 29 cases classified earlier as paralytic were found to be nonparalytic at the 50- to 70-day examination.

Another interesting relationship among these 666 subsequent cases is revealed in table 24. A high proportion of cases developing subsequent to paralytic index cases were paralytic, 75.9 percent, or fatal, 3.3 percent, whereas, among the cases developing subsequent to nonparalytic index cases a much lower proportion was paralytic, 47.1 percent, or fatal, 0.8 percent. Thus, the frequency of paralysis among subsequent cases was directly associated with the paralytic status of the index cases. Many factors may be involved in this association but at least one is the probable inclusion of some cases that were not poliomyelitis. Thus, in seeking a group of cases for the detailed analysis of the effects of gamma globulin the 415 paralytic cases that developed subsequent to paralytic index cases were considered to constitute the most specific and homogeneous group.

## Effects of Gamma Globulin

In searching for measures of the modifying effects of gamma globulin two general approaches were followed. The first was the relatively crude measure of a change in the proportion of paralytic and nonparalytic cases in relation to administration of gamma globulin. The second was a more detailed analysis of the comparative severity of the paralytic cases.

The first measure is shown in table 25, which compares the 7- to 14-day and 50- to 70-day classifications of paralysis. In 297 of the 666

**Table 23. Comparison of 7- to 14-day and 50- to 70-day classification of subsequent cases, among whites, 1 to 29 years old**

| 7- to 14-day classification | 50- to 70-day classification | | Total | Percent |
|---|---|---|---|---|
| | Paralytic | Nonparalytic | | |
| Paralytic | 309 | 29 | 338 | 50.8 |
| Nonparalytic [1] | 107 | 74 | 181 | 27.2 |
| Suspect [2] | 74 | 73 | 147 | 22.1 |
| Total | 490 | 176 | 666 | 100.0 |
| Percent | 73.6 | 26.4 | 100.0 | |

[1] Clinical manifestations suggesting nonparalytic poliomyelitis plus pleocytosis of 10 cells or more.
[2] Clinical manifestations suggesting nonparalytic poliomyelitis but either no pleocytosis or no lumbar puncture.

**Table 24. Number of cases, paralytic, nonparalytic and fatal among subsequent cases, white, age 1–29, by paralytic status of the index case**

| Involvement of subsequent case | Subsequent cases | | | | |
|---|---|---|---|---|---|
| | Number | | | Percent | |
| | Index case paralytic [1] | Index case nonparalytic | Total | Index case paralytic [1] | Index case nonparalytic |
| Paralytic [1] | 415 | 56 | 471 | 75.9 | 47.1 |
| Nonparalytic | 114 | 62 | 176 | 20.8 | 52.1 |
| Fatal | 18 | 1 | 19 | 3.3 | .8 |
| Total | 547 | 119 | 666 | 100.0 | 100.0 |

[1] 0.5 percent or greater muscle involvement, 50–70 day diagnosis, for both index and subsequent cases.

**Table 25. Comparison of 7- to 14-day with 50- to 70-day classification of paralysis according to administration of gamma globulin**

| 7- to 14-day classification | 50- to 70-day classification | Number of cases | | | |
|---|---|---|---|---|---|
| | | No gamma globulin | Gamma globulin given | | Total |
| | | | Before onset | On or after onset | |
| Paralytic | Paralytic | 140 | 111 | 58 | 309 |
| | Nonparalytic | 9 | 13 | 7 | 29 |
| | Total | 149 | 124 | 65 | 338 |
| Nonparalytic | Paralytic | 53 | 43 | 11 | 107 |
| | Nonparalytic | 30 | 32 | 12 | 74 |
| | Total | 83 | 75 | 23 | 181 |
| Suspect | Paralytic | 33 | 25 | 16 | 74 |
| | Nonparalytic | 32 | 26 | 15 | 73 |
| | Total | 65 | 51 | 31 | 147 |
| Total | Paralytic | 226 | 179 | 85 | 490 |
| | Nonparalytic | 71 | 71 | 34 | 176 |
| | Total | 297 | 250 | 119 | 666 |
| | | Percent of cases | | | |
| Paralytic | Paralytic | 94.0 | 89.5 | 89.2 | 91.4 |
| Nonparalytic [1] | do | 63.9 | 57.3 | 47.8 | 59.1 |
| Suspect [1] | do | 50.8 | 49.0 | 51.6 | 50.3 |
| Total | do | 76.1 | 71.6 | 71.4 | 73.6 |

[1] See footnotes to table 23.

total cases, gamma globulin was not administered; in 250 it was given before onset; in 119 it was given on or after onset.

Among the 338 cases classified as paralytic at the 7- to 14-day evaluation 91.4 percent were found to be paralytic at the 50- to 70-day examination. Among the 181 cases classified as nonparalytic early, 59.1 percent were found to be paralytic later. Similarly of the 147 suspect cases 50.3 percent were found to be paralytic later.

Only slight differences were observed in the proportion of paralytic cases in relation to the administration of gamma globulin. None of these differences were statistically significant. Thus, it could not be demonstrated that the administration of gamma globulin resulted in an appreciable reduction in the proportion of paralytic cases found at the 50- to 70-day examination.

The more detailed analysis was limited to the 415 paralytic cases that developed subsequent to paralytic index cases. These were separated into 7 groups according to the administration of gamma globulin. In 184 cases no gamma globulin was given. In 48 cases it was given 6 or more days before onset, in 55 cases it was given from 3 to 5 days before onset, and in another 55 cases, 1 to 2 days before onset. Gamma globulin was administered on the day of onset in 37 cases, from 1 to 2 days after onset in 21 cases, and from 3 to 8 days later in 15 cases.

These 415 cases were widely distributed among 32 States (table 26) roughly in proportion to the population and incidence of poliomyelitis cases during the year.

The intervals between onset and time of the physical therapists' examinations are summarized in table 27. While this examination has been referred to as the 50- to 70-day examination, actually a small number of cases

have been included in the analysis that were examined either earlier or later. However, 78 percent of the cases were examined within the specified period of 50 to 70 days, and, since there was no indication of selection of the remaining 22 percent of cases in any of the gamma globulin groups, their inclusion in the analysis was deemed warranted.

A study of the distribution of the 415 cases by age and sex (table 28) revealed the expected high proportion of cases in the 5- to 14-year group. Males were somewhat more frequent in the preschool children, but females were more than twice as frequent in the age group 15 to 29 years. This preponderance of females in the young adult group of subsequent cases may reflect the exposure of mothers to childhood index cases, although there may be other reasons. Furthermore, 23 of the 30 females in this group received gamma globulin before onset, 12 of them at least 6 days before.

The distribution of intervals between the onsets of the index cases and the 415 subsequent cases is shown in table 29. The distribution of the total cases follows extraordinarily closely the classical curve of the earlier epidemiologic studies. The distributions of the cases in the several gamma globulin groups vary in a logical manner. As pointed out earlier, a high proportion of the early subsequent cases could not be expected to receive gamma globulin prior to onset. More than half of the subsequent cases

**Table 26. Geographic distribution of the 415 cases, according to gamma globulin groups**

| State | No gamma globulin | Gamma globulin | | | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | | Days before onset | | | Day of or after onset | | | |
| | | 6+ | 3–5 | 1–2 | Same day | 1–2 | 3–8 | |
| Alabama | 3 | 1 | 1 | 1 | 2 | 1 | 1 | 10 |
| Arkansas | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| California [1] | 10 | 1 | 5 | 5 | 4 | 4 | 0 | 29 |
| Los Angeles | 2 | 0 | 0 | 1 | 2 | 0 | 0 | 5 |
| Colorado | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 3 |
| Connecticut | 2 | 0 | 2 | 0 | 1 | 0 | 0 | 5 |
| Florida | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 6 |
| Georgia | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| Illinois [1] | 11 | 5 | 1 | 4 | 7 | 0 | 2 | 30 |
| Chicago | 4 | 0 | 2 | 0 | 0 | 1 | 2 | 9 |
| Iowa | 8 | 4 | 2 | 1 | 0 | 1 | 0 | 16 |
| Kansas | 4 | 3 | 2 | 4 | 0 | 1 | 0 | 14 |
| Louisiana | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Maine | 6 | 0 | 2 | 0 | 2 | 0 | 0 | 10 |
| Maryland | 4 | 0 | 2 | 0 | 0 | 1 | 0 | 7 |
| Massachusetts | 8 | 3 | 2 | 4 | 0 | 0 | 1 | 18 |
| Michigan | 2 | 3 | 1 | 2 | 1 | 1 | 1 | 11 |
| Minnesota | 8 | 1 | 1 | 1 | 2 | 2 | 0 | 15 |
| Mississippi | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 3 |
| Missouri | 20 | 3 | 3 | 6 | 2 | 3 | 1 | 38 |
| Nebraska | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 4 |
| New York [1] | 26 | 11 | 10 | 6 | 5 | 0 | 2 | 60 |
| New York City | 3 | 0 | 1 | 0 | 2 | 0 | 0 | 6 |
| North Carolina | 11 | 4 | 2 | 2 | 3 | 2 | 1 | 25 |
| North Dakota | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Ohio | 7 | 1 | 2 | 1 | 2 | 2 | 3 | 18 |
| Oklahoma | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| Oregon | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 5 |
| Pennsylvania | 7 | 0 | 3 | 5 | 2 | 1 | 1 | 19 |
| Rhode Island | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 4 |
| South Carolina | 4 | 0 | 0 | 1 | 0 | 0 | 0 | 5 |
| Tennessee | 5 | 1 | 0 | 4 | 0 | 1 | 0 | 11 |
| Texas | 4 | 0 | 3 | 0 | 0 | 0 | 0 | 7 |
| Utah | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| Washington | 6 | 0 | 2 | 1 | 0 | 0 | 0 | 9 |
| Total | 184 | 48 | 55 | 55 | 37 | 21 | 15 | 415 |

[1] Exclusive of cases from cities listed.

coming down 6 or more days after the index case, however, did receive gamma globulin. As the interval from index to subsequent case increased, so did the proportion of subsequent cases receiving gamma globulin 6 days or more before developing the disease. As might be expected, the cases receiving gamma globulin, on or after onset, were concentrated largely among the early subsequent cases.

The summary in table 29 presents the distribution of intervals of the total group in a manner comparable to the distributions shown previously in table 20. In order to make this summary table comparable it was necessary to add 45 co-index cases since these had been included in the distribution of earlier years. In the present study the proportions of the subsequent cases in the three interval groups fall well within the rather narrow variations of past experience. This similarity is remarkable because the present series is based on white paralytic cases 1 to 29 years of age classified by a physical therapist's examination, while the earlier series were not so carefully evaluated.

There were 30 cases that occurred 13 to 30 days after the onset of the index cases. Of these, 19 received gamma globulin before onset, 16, six days or more before onset at a time when the greatest prophylactic effect of gamma globulin should have been acting. These 30

**Table 27. Intervals between onset and time of "50–70 day" muscle evaluation in 415 cases, according to gamma globulin group**

| Interval (days) | No gamma globulin | Gamma globulin | | | | | | Total cases |
|---|---|---|---|---|---|---|---|---|
| | | Days before onset | | | Day of onset | Days after onset | | |
| | | 6+ | 3–5 | 1–2 | | 1–2 | 3–8 | |
| 31–44 | 4 | 1 | 2 | 2 | 2 | 1 | | 12 |
| 45–49 | 7 | 2 | 7 | 2 | 5 | 2 | | 25 |
| 50–70 | 148 | 43 | 37 | 45 | 25 | 16 | 10 | 324 |
| 71–75 | 10 | | 1 | 2 | | | 2 | 15 |
| 76–125 | 15 | 2 | 8 | 4 | 5 | 2 | 3 | 39 |
| Total | 184 | 48 | 55 | 55 | 37 | 21 | 15 | 415 |

**Table 28. Age and sex distribution of 415 cases, according to gamma globulin group**

| Age and sex | No gamma globulin | Gamma globulin | | | | | | Total cases |
|---|---|---|---|---|---|---|---|---|
| | | Days before onset | | | Day of onset | Days after onset | | |
| | | 6+ | 3–5 | 1–2 | | 1–2 | 3–8 | |
| 1–4 years: | | | | | | | | |
| Male | 19 | 4 | 11 | 10 | 9 | 1 | 1 | 55 |
| Female | 17 | 4 | 6 | 7 | 3 | 2 | 2 | 41 |
| 5–14 years: | | | | | | | | |
| Male | 59 | 17 | 11 | 16 | 5 | 3 | 2 | 113 |
| Female | 44 | 10 | 20 | 15 | 16 | 5 | 4 | 113 |
| 15–29 years: | | | | | | | | |
| Male | 15 | 1 | 3 | | 3 | 3 | 2 | 27 |
| Female | 30 | 12 | 4 | 7 | 1 | 7 | 4 | 65 |
| Total: | | | | | | | | |
| Male | 93 | 22 | 25 | 26 | 17 | 7 | 5 | 195 |
| Female | 91 | 26 | 30 | 29 | 20 | 14 | 10 | 220 |
| Total | 184 | 48 | 55 | 55 | 37 | 21 | 15 | 415 |

**Table 29. Distribution of intervals between onset of the index cases and the 415 subsequent cases, according to gamma globulin groups**

| Interval (days) | No gamma globulin | Gamma globulin | | | | | | Total cases |
|---|---|---|---|---|---|---|---|---|
| | | Days before onset | | | Day of onset | Days after onset | | |
| | | 6+ | 3–5 | 1–2 | | 1–2 | 3–8 | |
| 1 | 40 | | | 1 | 1 | 3 | 6 | 51 |
| 2 | 22 | | 1 | 4 | 9 | 3 | 2 | 41 |
| 3 | 21 | 1 | 3 | 9 | 8 | 3 | | 45 |
| 4 | 24 | | 1 | 11 | 5 | 3 | 4 | 48 |
| 5 | 18 | 1 | 6 | 8 | 5 | 3 | | 41 |
| 6 | 15 | 1 | 7 | 9 | 1 | | | 33 |
| 7 | 11 | 3 | 8 | 4 | 1 | 4 | 1 | 32 |
| 8 | 9 | 2 | 10 | | 4 | 1 | | 26 |
| 9 | 2 | 7 | 4 | 4 | 1 | 1 | 1 | 20 |
| 10 | 5 | 3 | 5 | 3 | 1 | | | 17 |
| 11 | 2 | 9 | 6 | 2 | | | 1 | 20 |
| 12 | 1 | 2 | 1 | | 1 | | | 5 |
| 13–30 | 11 | 16 | 3 | | | | | 30 |
| 31–43 | 3 | 3 | | | | | | 6 |
| Total | 184 | 48 | 55 | 55 | 37 | 21 | 15 | 415 |

cases comprise 6.6 percent of the total series, which is well within the expected range had none received gamma globulin. Thus, the availability in 1953 of gamma globulin on a national basis for administration to household associates did not induce a discernible deviation in the classical epidemiologic pattern of the familial aggregation of the disease.

The severity of muscle involvement of the 415 cases is presented in table 30, for each of the gamma globulin groups. A large proportion of the cases were mild. The geometric mean for the total group was 6.1 percent muscle involvement, and approximately one-third had involvements greater than 9.5 percent.

A comparison of the mean percent involvement for each of the 7 gamma globulin groups reveals a variation ranging from 4.2 percent to 7.0 percent without apparent trend. Another index of severity in the distributions was the percent "severe" cases arbitrarily defined as those having 9.5 percent or greater, muscle involvement. In the group receiving no gamma globulin, 32.1 percent were thus classified as severe. The comparable figures for the groups receiving gamma globulin before onset were 27.1, 40.0, and 30.1 percent. Slightly lower figures were observed in the groups that received gamma globulin on or after onset. None of these slight differences were statistically significant.

**Summary of table 29**

| Interval (days) | Number of cases | Percent |
|---|---|---|
| 0–5 | [1] 271 | [1] 59. 7 |
| 6–12 | 153 | 33. 7 |
| 13–30 | 30 | 6. 6 |
| Total | 454 | 100. 0 |

[1] Includes 45 co-index cases selected from the total of 80 co-index cases of the total series on the same basis as the 415 cases were selected from the 817 of the total series.

A total of 18 deaths occurred among the white subsequent cases 1 to 29 years of age. These were not included among the 415 cases because muscle scores were obviously not available. These deaths are shown at the bottom of table 30. In half of these gamma globulin was not given, in seven it was given before onset, and in two, after onset. While the numbers are small, there is no suggestion of difference in case fatality rates in relation to administration of gamma globulin.

The distributions of muscle involvement according to age groups and intervals between index and subsequent cases are shown in table 31. The severity of paralysis among the cases from 1 to 4 and from 5 to 14 years of age was milder than among the age group 15 to 29. This difference is shown both by the geometric

**Table 30. Distribution of severity of paralysis based on the 50- to 70-day muscle examination and distribution of deaths, according to gamma globulin group**

| Percent muscle involvement | No. gamma globulin | Gamma globulin | | | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | | Days before onset | | | Day of or after onset | | | |
| | | 6+ | 3–5 | 1–2 | Same day | 1–2 | 3–8 | |
| 0.5–1.4 | 18 | 5 | 7 | 3 | 4 | 2 | 3 | 42 |
| 1.5–2.4 | 26 | 7 | 3 | 10 | 6 | 2 | 2 | 56 |
| 2.5–3.4 | 18 | 6 | 5 | 5 | 2 | 2 | 2 | 40 |
| 3.5–4.4 | 22 | 4 | 6 | 7 | 3 | 0 | 1 | 43 |
| 4.5–5.4 | 15 | 2 | 4 | 3 | 3 | 4 | 1 | 32 |
| 5.5–6.4 | 10 | 5 | 3 | 3 | 3 | 2 | 2 | 28 |
| 6.5–7.4 | 7 | 4 | 2 | 3 | 3 | 3 | 0 | 22 |
| 7.5–8.4 | 5 | 1 | 3 | 3 | 2 | 0 | 0 | 14 |
| 8.5–9.4 | 4 | 1 | 0 | 1 | 1 | 1 | 0 | 8 |
| 9.5–24.4 | 26 | 10 | 13 | 10 | 4 | 3 | 3 | 69 |
| 24.5–49.4 | 17 | 1 | 6 | 3 | 2 | 1 | 1 | 31 |
| 49.5–99.9 | 16 | 2 | 3 | 4 | 4 | 1 | 0 | 30 |
| Total | 184 | 48 | 55 | 55 | 37 | 21 | 15 | 415 |
| Geometric mean | 6. 3 | 5. 1 | 7. 0 | 6. 0 | 6. 1 | 5. 9 | 4. 2 | 6. 1 |
| Percent severe cases [1] | 32. 1 | 27. 1 | 40. 0 | 30. 1 | 27. 0 | 23. 8 | 26. 7 | 31. 3 |
| Number of deaths | 9 | 2 | 2 | 3 | 0 | 2 | 0 | 18 |

[1] Cases having 9.5 percent or greater involvement.

mean and the percent of severe cases. This trend reflects the expected increase in severity of paralysis with age. Contrary to expectation, no correlation or trend was observed in the severity of subsequent cases according to interval from the index case.

Recognizing the existence of a relation between age and severity, and the fact that the age composition of the gamma globulin groups differed, a statistical analysis was undertaken that would permit measurement of the factors independently.

## Further Statistical Analysis

An appropriate method for the more precise statistical analysis was a factorial analysis of variance adapted to unequal subclass numbers. The method has been described by various authors, for example: "The Design and Analysis of Experiments," by Oscar Kempthorne, New York, John Wiley and Sons, Inc., 1952.

Table 32 shows the variability of the subclasses. It will be noted, for example, that the composition of the group receiving no gamma globulin is quite different with respect to interval between onset of index and subsequent case from the group receiving gamma globulin 6 or more days before onset. Also, the age distribution of the cases receiving gamma globulin after onset is older than that of the groups receiving gamma globulin 1 to 5 days before onset.

In order to appraise the effect of gamma globulin with removal of the bias introduced by different composition of the seven gamma globulin groups with respect to these secondary factors, a special procedure was employed prior to analysis of variance. The method is based on the premise that the 50- to 70 day severity of each case can be resolved into additive components associated with age, index-subsequent case onset interval, and administration of gamma globulin. This statement may be expressed more precisely in terms of an equation

$$Y_{hijk}=u+g_h+a_i+t_j+e_{hijk}$$

in which $Y_{hijk}$ represents the 50- to 70-day severity (in percent) of a particular individual; "u" represents a "base-line" average severity of all individuals in the study; "$g_h$", an average component characteristic of all individuals who received gamma globulin during a specific

time interval, h, relative to their onset; "$a_i$", an average component characteristic of all individuals in a particular age group, i; "$t_j$" a component characteristic of all individuals whose onset fell in a specific time interval, j, relative to onset of the index case; and "$e_{hijk}$", a residual "random" element representing an individual's departures from the average values of the group of individuals into which he is classified. Such departures result from various causes not identified in the mathematical model.

The analysis was carried out in logarithms of the percent involvement at the 50- to 70-day examination and thus provides comparisons based on geometric rather than arithmetic means.

Technically, the procedure consisted of forming a set of normal equations based on the frequencies in table 32 and the totals of the percent involvement for the various groups. The normal equations are shown in table 33. Solution of the equations yielded an estimate

**Table 31. Distribution of severity of paralysis based on the 50- to 70-day muscle examination among the 415 cases, according to age and to interval between onsets of index and subsequent cases**

| Percent muscle involvement | Age in years | | | | Interval in days | | | Total |
|---|---|---|---|---|---|---|---|---|
| | 1–4 | 5–14 | 15–29 | Total | 1–3 | 4–7 | 8+ | |
| 0.5–1.4 | 7 | 26 | 9 | 42 | 17 | 14 | 11 | 42 |
| 1.5–2.4 | 16 | 30 | 10 | 56 | 22 | 21 | 13 | 56 |
| 2.5–3.4 | 4 | 28 | 8 | 40 | 11 | 14 | 15 | 40 |
| 3.5–4.4 | 10 | 24 | 9 | 43 | 9 | 21 | 13 | 43 |
| 4.5–5.4 | 8 | 16 | 8 | 32 | 14 | 10 | 8 | 32 |
| 5.5–6.4 | 8 | 15 | 5 | 28 | 12 | 8 | 8 | 28 |
| 6.5–7.4 | 12 | 9 | 1 | 22 | 7 | 6 | 9 | 22 |
| 7.5–8.4 | 3 | 11 | | 14 | 2 | 6 | 6 | 14 |
| 8.5–9.4 | 1 | 4 | 3 | 8 | 1 | 4 | 3 | 8 |
| 9.5–24.4 | 20 | 34 | 15 | 69 | 20 | 27 | 22 | 69 |
| 24.5–49.4 | 5 | 14 | 12 | 31 | 10 | 12 | 9 | 31 |
| 49.5–99.5 | 2 | 16 | 12 | 30 | 12 | 11 | 7 | 30 |
| Total | 96 | 227 | 92 | 415 | 137 | 154 | 124 | 415 |
| Geometric mean | 5.8 | 5.6 | 7.9 | 6.1 | 6.0 | 6.1 | 6.3 | 6.1 |
| Percent severe cases [1] | 28.1 | 28.2 | 42.4 | 31.3 | 30.7 | 32.5 | 30.6 | 31.3 |

[1] Cases having 9.5 percent or greater involvement.

**Table 32. Distribution of the 415 subsequent cases, by age, interval between onset of index and subsequent case, and administration of gamma globulin**

| Age (years) | Index-subsequent onset interval (days) | No gamma globulin given | Administration of gamma globulin | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | | Days before onset | | | Same day | Days after onset | | |
| | | | 6+ | 3–5 | 1–2 | | 1–2 | 3+ | |
| 1–4 | 1–3 | 19 | | | 6 | 9 | 2 | 1 | 37 |
| | 4–7 | 15 | | 10 | 10 | 2 | 1 | 1 | 39 |
| | 8+ | 2 | 8 | 7 | 1 | 1 | | 1 | 20 |
| 5–14 | 1–3 | 52 | 1 | 2 | 8 | 8 | 5 | 4 | 80 |
| | 4–7 | 33 | 2 | 12 | 17 | 9 | 3 | 2 | 78 |
| | 8+ | 18 | 24 | 17 | 6 | 4 | | | 69 |
| 15–29 | 1–3 | 12 | | 2 | | 1 | 2 | 3 | 20 |
| | 4–7 | 20 | 3 | | 5 | 1 | 6 | 2 | 37 |
| | 8+ | 13 | 10 | 5 | 2 | 2 | 2 | 1 | 35 |
| Total cases | | 184 | 48 | 55 | 55 | 37 | 21 | 15 | 415 |

**Table 33. Normal equations (in matrix notation) for analysis of the 415 subsequent cases**

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 184 | | | | | | | 36 | 103 | 45 | 83 | 68 | 33 | | $g_1$ | | $\Sigma \log Y_{hijk}$ |
| | 48 | | | | | | 8 | 27 | 13 | 1 | 5 | 42 | | $g_2$ | | 147. 6059 |
| | | 55 | | | | | 17 | 31 | 7 | 4 | 22 | 29 | | $g_3$ | | 34. 0891 |
| | | | 55 | | | | 17 | 31 | 7 | 14 | 32 | 9 | | $g_4$ | | 46. 5040 |
| | | | | 37 | | | 12 | 21 | 4 | 18 | 12 | 7 | | $g_5$ | | 42. 8235 |
| | | | | | 21 | | 3 | 8 | 10 | 9 | 10 | 2 | | $g_6$ | | 29. 1434 |
| | | | | | | 15 | 3 | 6 | 6 | 8 | 5 | 2 | | $g_7$ | | 16. 1631 |
| | | | | | | | | | | | | | x | | = | 9. 3158 |
| 36 | 8 | 17 | 17 | 12 | 3 | 3 | 96 | | | 37 | 39 | 20 | | $a_1$ | | 73. 1099 |
| 103 | 27 | 31 | 31 | 21 | 8 | 6 | | 227 | | 80 | 78 | 69 | | $a_2$ | | 169. 9710 |
| 45 | 13 | 7 | 7 | 4 | 10 | 6 | | | 92 | 20 | 37 | 35 | | $a_3$ | | 82. 5639 |
| 83 | 1 | 4 | 14 | 18 | 9 | 8 | 37 | 80 | 20 | 137 | | | | $t_1$ | | 106. 2716 |
| 68 | 5 | 22 | 32 | 12 | 10 | 5 | 39 | 78 | 37 | | 154 | | | $t_2$ | | 120. 4305 |
| 33 | 42 | 29 | 9 | 7 | 2 | 2 | 20 | 69 | 35 | | | 124 | | $t_3$ | | 98. 9427 |

Key:

$g_1$ = No gamma globulin
With gamma globulin
$g_2$ = 6 or more days before onset
$g_3$ = 3 to 5 days before onset.
$g_4$ = 1 to 2 days before onset.
$g_5$ = On day of onset.
$g_6$ = 1 to 2 days after onset.
$g_7$ = 3 or more days after onset.

$a_1$ = Age 1 to 4 years.
$a_2$ = Age 5 to 14 years.
$a_3$ = Age 15 to 29 years.

$t_1$ = Subsequent onset 1 to 3 days after index case.
$t_2$ = Subsequent onset 4 to 7 days after index case.
$t_3$ = Subsequent onset 8 or more days after index case.

of the average value of each factor and these are shown in table 34.

Table 35 shows the numerical value of each component measured as a departure from the average of its group; and the standard error of each component. It may be noted that only one of the 13 components, $a_3$ (age group 15 to 29), exceeded twice its standard error.

Table 36 provides the sums of squares and F ratios for testing significance of each group of factors. It is readily apparent that there were no indications of any differences of statistical significance in the comparisons relating to gamma globulin or to interval between onset of index and subsequent case. With regard to age, however, the average severity among those in the age group 15 to 29 was significantly greater than among those under 15. Estimates (geometric mean) of average severity in muscle score percent were: age 1 to 4, 5.3 percent; age 5 to 14, 5.2 percent; and age 15 to 29, 7.7 percent.

Table 37 shows individual tests of significance between the group which did not receive gamma globulin and each of the six groups which did receive gamma globulin. It is evident that none of these differences is of statistical significance. It will be noted that the 2 groups receiving gamma globulin 3 to 5 days and 6 or more days before onset include relatively small numbers of subsequent cases occurring 1 to 3 days after onset, of the index case. Had the difference in severity been dissimilar among the respective groups of subsequent cases occurring 1 to 3, 4 to 7, and 8 or more days after onset, it would have been necessary to give additional attention to this factor in interpreting the effect of gamma globulin on severity. Since severity among subsequent cases in each of the three interval groups turned out to be very similar, the problem is of no consequence.

In 749 multiple-case households, 1,654 individual patients with poliomyelitis were studied. Of this number, 749 were index cases, 8 were prior cases, 80 were co-index cases, and 817 became ill 1 or more days after the index case. For various reasons, depending mostly upon the time required for recognition of the index case and the large proportion of secondary cases which develop simultaneously with or very shortly after the index case, only about one-third of the subsequent cases received gamma globulin before onset of their illness. To determine whether or not gamma globulin modified the severity of paralysis in these patients, the extent of muscle involvement in this group as well as in other groups of subsequent cases who

**Table 34. Solutions of the normal equations**

$\mu = 0.775088$

$$\begin{Bmatrix} g_1 \\ g_2 \\ g_3 \\ g_4 \\ g_5 \\ g_6 \\ g_7 \end{Bmatrix} = \begin{Bmatrix} 0.008451 & -0.000852 & 0.000051 & 0.000885 & -0.000163 & -0.002828 & -0.005545 \\ -0.000852 & 0.024279 & 0.000877 & -0.002481 & -0.003774 & -0.007803 & -0.010247 \\ 0.000051 & 0.000877 & 0.018793 & -0.000902 & -0.002657 & -0.006751 & -0.009411 \\ 0.000885 & -0.002481 & -0.000902 & 0.017949 & -0.002012 & -0.005273 & -0.008166 \\ -0.000163 & -0.003774 & -0.002657 & -0.002012 & 0.024106 & -0.006522 & -0.008978 \\ -0.002828 & -0.007803 & -0.006751 & -0.005273 & -0.006522 & 0.039948 & -0.010771 \\ -0.005545 & -0.010247 & -0.009411 & -0.008166 & -0.008978 & -0.010771 & 0.053118 \end{Bmatrix} \times \begin{Bmatrix} 2.759203 \\ -4.075233 \\ 4.030041 \\ 0.492762 \\ 0.689633 \\ -1.054425 \\ -2.841980 \end{Bmatrix} = \begin{Bmatrix} 0.046054 \\ -0.064233 \\ 0.103890 \\ 0.045142 \\ 0.052249 \\ -0.021816 \\ -0.161286 \end{Bmatrix}$$

$$\begin{Bmatrix} a_1 \\ a_2 \\ a_3 \end{Bmatrix} = \begin{Bmatrix} 0.006711 & -0.002000 & -0.004712 \\ -0.002000 & 0.004393 & -0.002393 \\ -0.004712 & -0.002393 & 0.007105 \end{Bmatrix} \times \begin{Bmatrix} -2.308946 \\ -8.581502 \\ 10.890447 \end{Bmatrix} = \begin{Bmatrix} -0.049646 \\ -0.059148 \\ 0.108794 \end{Bmatrix}$$

$$\begin{Bmatrix} t_1 \\ t_2 \\ t_3 \end{Bmatrix} = \begin{Bmatrix} 0.006108 & -0.001883 & -0.004224 \\ -0.001883 & 0.004995 & -0.003111 \\ -0.004224 & -0.003111 & 0.007335 \end{Bmatrix} \times \begin{Bmatrix} 0.638903 \\ -2.140985 \\ 1.502082 \end{Bmatrix} = \begin{Bmatrix} 0.001590 \\ -0.016570 \\ 0.014980 \end{Bmatrix}$$

Key: See table 33.

either received no gamma globulin or received it on or after onset, was carefully measured by specially trained physical therapists. For a number of reasons, fully discussed in the text, most extensive analysis was limited to 415 patients who exhibited paralysis 50 to 70 days after onset of their illness. Of these 415 patients, 158 received gamma globulin before onset, 184 received no gamma globulin, and 73 received it on or after onset. A statistical analysis showed no significant difference in the extent of muscle involvement in those who received gamma globulin before onset, as compared with those who received none or received it on the day of or after onset.

Another question investigated was whether the administration of gamma globulin resulted in the finding of a higher proportion of nonparalytic cases at the 50- to 70-day examination. No significant differences were found.

An analysis of the familial aggregation of all subsequent cases was made in order to obtain an indication as to whether or not the administration of gamma globulin may have prevented a considerable proportion of the cases that are expected to occur 13 to 30 days after the first case in the family. To permit comparison with the established pattern of previous years, it was necessary to include all the data obtained from multiple case households regardless

**Table 35. Calculated estimates of the individual age, interval, and gamma globulin components, and their standard errors**

| Components | | Deviation from mean of group | Standard error of deviation |
|---|---|---|---|
| Gamma globulin: | | | |
| None | $g_1$ | 0. 046 | 0. 046 |
| Before onset: | | | |
| 6+days | $g_2$ | −. 064 | . 078 |
| 3–5 days | $g_3$ | . 104 | . 069 |
| 1–2 days | $g_4$ | . 045 | . 067 |
| 0 days | $g_5$ | . 052 | . 078 |
| After onset: | | | |
| 1–2 days | $g_6$ | −. 022 | . 100 |
| 3+days | $g_7$ | −. 161 | . 115 |
| Age: | | | |
| 1–4 years | $a_1$ | −. 050 | . 041 |
| 5–14 years | $a_2$ | −. 059 | . 033 |
| 15–29 years | $a_3$ | . 109 | . 042 |
| Index-subsequent onset interval: | | | |
| 1–3 days | $t_1$ | . 002 | . 039 |
| 4–7 days | $t_2$ | −. 017 | . 035 |
| 8+days | $t_3$ | . 015 | . 043 |

**Table 36. F-tests for effects of gamma globulin, age, and interval components**

| Source of sum of squares | Degrees of freedom | Sum of squares | Mean square $\left(\frac{\text{S. S.}}{\text{D. F.}}\right)$ | Ratio of mean square to residual mean square (F) | P |
|---|---|---|---|---|---|
| Total | 415 | 359. 5214 | | | |
| Fitting ($\mu$, g, a, t) | 11 | 258. 3986 | | | |
| Fitting mean alone | 1 | 255. 5290 | | | |
| Difference | 10 | 2. 8696 | 0. 2870 | 1. 147 | 0. 50 $<$P$<$0. 70 |
| Gamma globulin components | 6 | 1. 3472 | . 2245 | . 897 | . 50 $<$P$<$ . 70 |
| Age components | 2 | 1. 8070 | . 9035 | 3. 610 | . 025$<$P$<$ . 05 |
| Interval components | 2 | . 0590 | . 0295 | . 118 | . 10 $<$P$<$ . 20 |
| Residual | 404 | 101. 1228 | . 2503 | | |

Table 37. Individual tests of significance of the gamma globulin components

| Comparison of group receiving no gamma globulin with groups receiving gamma globulin | Difference between components $g_1-g_i$ | Standard error of difference | Ratio of difference to standard error | P |
|---|---|---|---|---|
| 6 or more days before onset ($g_1-g_2$) | 0. 1103 | 0. 0928 | 1. 19 | 0. 23 |
| 3–5 days before onset ($g_1-g_3$) | —. 0578 | . 0824 | —. 70 | . 48 |
| 1 to 2 days before onset ($g_1-g_4$) | . 0009 | . 0785 | . 01 | . 99 |
| On day of onset ($g_1-g_5$) | —. 0062 | . 0907 | —. 07 | . 94 |
| 1 to 2 days after onset ($g_1-g_6$) | . 0679 | . 1163 | . 58 | . 56 |
| 3 or more days after onset ($g_1-g_7$) | . 2073 | . 1349 | 1. 54 | . 12 |

of whether or not gamma globulin was given to any member of the household before the appearance of the subsequent case. When this was done, the pattern turned out to be similar to that observed in previous years when no gamma globulin was used.

There may be several alternative explanations for the apparent lack of effectiveness of gamma globulin in familial associates of patients with poliomyelitis: (*a*) gamma globulin preparations may contain too little antibody to be effective in the dosage used, or (*b*) gamma globulin of adequate antibody content may be ineffective when it is given to patients after they have been infected, and the vast majority, if not all familial associates of a case, may already be infected by the time the first case is diagnosed or by the time inoculations can be given.

## Conclusions

The data on the efficacy of gamma globulin in household contacts that have been accumulated in 1953 are considered to be adequate for reliable conclusions. They indicate that with the preparations employed and in the dosages used, the administration of gamma globulin to familial associates of patients with poliomyelitis had no significant influence on:

1. The severity of paralysis developing in subsequent cases.
2. The proportion of nonparalytic poliomyelitis among the subsequent cases who received gamma globulin before onset.
3. The classical pattern of familial aggregation of cases in the country at large.

## Summary

Multiple cases of clinically diagnosed poliomyelitis occur in 3 to 5 percent of households. The interval between the first and subsequent cases has followed a rather characteristic pattern in many different epidemics. On the average, 60 percent of subsequent cases occur within 5 days after the first case, 30 percent in 6 to 12 days, and approximately 10 percent in 13 to 30 days. Gamma globulin was administered to familial associates of patients on the assumption that the paralysis might be in much milder form in those who would ordinarily develop it within 7 days of inoculation, while in a considerable proportion of the remainder paralysis might be completely prevented.

# *Chapter VI*

# Administrative Aspects

## Gamma Globulin for Household Contacts

In order to evaluate more fully the 1953 data, and to plan better distribution systems in the future, it was desirable to determine whether the basic objectives, rapid and equitable distribution of available supplies, were successfully accomplished. Particular phases of the distribution systems, as well as certain information concerning reporting, will be discussed in the following sections.

Information was gathered by the Communicable Disease Center's statisticians, and in some instances, by the Epidemic Intelligence Service officers, from 32 States and the city of Chicago. A questionnaire concerning procedure was used to provide comparable types of information. The information collected will be discussed in general terms.

The directive of the Office of Defense Mobilization, dated April 15, 1953, recommended individual inoculation with gamma globulin to three types of contacts. Eligibles primarily were persons under 30 years of age or pregnant women of any age who were household contacts of clinically diagnosed cases. In addition, intimate contacts outside of the household, or household contacts of suspect cases, were considered to be eligible recipients of gamma globulin if circumstances warranted it. The terms "household," "clinical stage," and "infective stage," were not defined.

The inoculation of contacts is predicated upon a report of a case of poliomyelitis. In general, the States provided memoranda discussing criteria for an acceptable diagnosis of poliomyelitis, or referred the practitioner to some reliable source of information. Several States requested either evidence of paralysis or a positive spinal fluid finding in the index case. The physician's diagnosis was then accepted. Actually, all cases in a number of States were investigated (New York, Connecticut, Massachusetts, Rhode Island, and Illinois) to obtain epidemiological information, and a high percentage of cases were hospitalized in nearly every State. If one combines the efforts of local health agencies and medical societies and the activities of the National Foundation for Infantile Paralysis, the coverage was such that a very small percentage of cases was not confirmed in some way, even though State regulations did not *demand* confirmation.

The directive specifically states: "III.2. The State or Territorial health officer shall have full responsibility for the distribution of the gamma globulin allocated to him. He shall decide the modes of prophylaxis which are most appriate for use within his jurisdiction." However, there was a definite tendency to adhere closely to the recommendations and to interpret them in narrow terms, taking little chance of including anyone not completely eligible by the directive.

Some modifications of the recommendations from the Office of Defense Mobilization were made in various States, usually to meet the problems of the specific State in providing an equitable distribution without endangering the supply. The age limit of 30 for eligible household contacts was reduced to 20 in Kansas, 19 in Wisconsin, 18 in Maryland, 16 in Oklahoma, and 15 in Minnesota. Illinois modified the whole definition to include persons remaining in the household for 24 hours during the communicable stage. Nebraska included contacts in the home for 24 hours during the 72 hours prior to onset. Ohio included cases judged to be intimate contacts by a county commission with the aid of the State Department of Health. In Texas, the physician, upon proper application, was automatically provided with 60 ml. of gamma globulin. The physician was to dispense this to contacts according to his own judgment.

The various systems in the different States were influenced to a great extent by the manner in which this program could be integrated with

the regular health program without undue expenditure of extra manpower, equipment, or funds.

The method of distribution of gamma globulin varied in the different States. Twenty-six of the States had local or area distribution points operated by or under the supervision of local, county, or district health offices. Idaho, Minnesota, New Hampshire, North Dakota, Rhode Island, and Vermont distributed all gamma globulin from State headquarters. New Hampshire and Vermont were novel in that the State police system was utilized to provide express delivery. Kansas used hospitals exclusively as distribution points.

It was the general opinion of health officials in the solicited States that gamma globulin could be provided within 5 days after onset of the index case, and in most States this limit could be reduced to 3 days. It should be borne in mind that the time from onset of an index case until inoculation of contacts consists of three parts: first, the time for discovery, diagnosis, and request; second, the time to clear the request and deliver the gamma globulin; and third, the time between delivery and injection. The State health officials can only control the second part, and the physician has only partial control over the first and third, so that the problem of administration is a diffuse responsibility of the household, the doctor, and the health agency.

Most of the States filled orders upon telephone requests from a physician, to be followed by a written form identifying the index case of poliomyelitis and the contacts. Eight States (Arkansas, Connecticut, Massachusetts, Mississippi, Nebraska, North Carolina, Oklahoma, and Pennsylvania) required written requests before the release of gamma globulin. Chicago followed this practice. Idaho, New Hampshire, and Vermont required only telephone requests.

In 17 States, the requests for gamma globulin were screened chiefly for procedure and completeness.

## Changes During the Year

The above information was obtained from the States during July and August. The basic allotment to each State (the product of the 5-year average of reported cases (1947–51) and 60 ml. of gamma globulin per case), comprising some 1,700 liters, was distributed by June 25, 1953. Additional allocations became available on August 17 and September 25. Due to the generally lower incidence of reported poliomyelitis, compared to 1952, and the additional allocations, a number of States officially changed their definitions of eligibility or permitted a wider interpretation of established definitions later in the season. For example, Minnesota raised its age limit twice and New York raised its age limit in addition to defining certain new eligibles. All the variations can not be described here.

## Effect of Gamma Globulin on Reporting

Early in the year the prediction was not uncommon that gamma globulin would produce gross over-reporting of poliomyelitis. It was thought that some measure of over-reporting could be found, but examination of the data of previous years indicated that a procedure which was uniformly applicable was not available. Over the years 1949–53, the annual percentage of cases specified by type to be paralytic, rather than nonparalytic, was compared in Connecticut, Georgia, Massachusetts, Michigan, and New York. Not only were the differences considerable between States, but within States they varied from year to year. New York disagreed with the others in both the magnitude and the direction of change. The others agreed reasonably well, showing an average increase in paralytic cases of 9 percent from 1949 to 1950, a decrease of 15 percent in 1951, an increase of 13 percent in 1952, and a decrease of 20 percent in 1953. The percentage in New York decreased 7 percent, then 1.5 percent, then 0.5 percent, and then increased 2 percent in 1953.

The weekly percentage of paralytic cases by week during the period June 6 to October 17, as given by the *Weekly Morbidity Reports* of the National Office of Vital Statistics, was observed for these same States. Early in June the incidence of cases was low, but the percentage of paralytic cases was relatively high; thereafter, a decline of paralytic cases proceeded until the middle of July. It remained constant until the

middle of August, then gradually rose until the end of the study period. The national percentage of paralytic cases followed the same trend. Thus, the shift in 1953 is consistent with previous annual and monthly changes.

Opinions of various State health officials agreed that general over-reporting had not been prominent up to the time of interview (July–August). It was thought that more critical diagnostic criteria were used, and that minor paralysis, which might have been passed over in previous years, was being detected. Reporting of cases as paralytic or nonparalytic was uniformly attempted for the first time, although approximately half of the cases were not so specified. In addition, the reporting was believed to be more prompt than in previous years because of the stimulus of the availability of gamma globulin for household contacts.

## Mass Use of Gamma Globulin

The administrative problems relating to the mass use of gamma globulin are many. The outstanding difficulties are: (*a*) the lack of precise methods for predicting the course of any given outbreak; (*b*) the delay, because of involved procedural requirements, in obtaining gamma globulin by the health department after an area was certified; (*c*) the time required to organize the necessary community resources to staff and manage the mass inoculation clinics.

No attempt will be made in this report to evaluate these problems.

## Problems Relating to Publicity

A number of local health officers complained that they were hampered in the problems of distribution by releases which appeared in the press prior to receipt of instructions from central agencies. Such press releases were said to have been originated sometimes by Federal agencies, sometimes by State agencies, and sometimes by nongovernmental bodies. The net result of such premature releases was that private physicians frequently obtained information about gamma globulin from their patients who had read about it in the newspapers. Occasionally, the information given in the press was in contradiction to the information received from the State health officer. Thus, in one instance, the press stated that gamma globulin would be employed only in epidemic areas, whereas the correct information released by the State health officer was that the material would be issued to all counties for use in household contacts.

If more attention had been given to the timing of such press releases, no statement would have been made to the press until a definite policy had been adopted by an authorized agency. Furthermore, no releases would have been given to the press until sufficient time had elapsed to acquaint the local health officers and the private physicians with the contents of the official directive.

## Summary and Conclusions

Administrative problems relating to the distribution of gamma globulin for inoculation of household associates within the States were few after the material was received. The establishment, in advance, of definite criteria for its use relieved pressure on practicing physicians and health departments. The evidence indicates that once a request had been properly made, the gamma globulin was provided promptly. The major delay centered around the interval between onset of the index cases and their diagnosis; nevertheless, in several states from which data are available, gamma globulin was given to the great majority of household associates within an average of 5 days from the onset of the index cases. If gamma globulin is to be given earlier, it is apparent that efforts must be made to obtain earlier recognition of the first cases.

On the other hand, it has been pointed out that the procedure for obtaining gamma globulin for mass use in epidemic areas was necessarily involved. Because of the difficulty in making accurate predictions, the level of incidence required, and the need for approval of a request, the time required to carry out the mass procedure was likely to delay administration until the peak was well past.

# *Comment on the Study*

by

W. McD. Hammon, M.D.

Since I, together with my able associates, Dr. Coriell and Dr. Stokes, am responsible in part for the use of gamma globulin in poliomyelitis, and since I am a member of the committee participating in preparing the foregoing report, some comment might be expected. This is particularly true since the casual reader and the reader of press interpretations may conclude that the report indicates that all of the conclusions drawn from the experiments with carefully selected controls conducted in 1951 and 1952 are now invalidated.

The foregoing report and conclusions of the committee have been carefully and conservatively worded, by a group having high regard for the necessity of controls and of careful statistical evaluation. The report points out that to make any valid analysis in respect to any effect of gamma globulin on prevention in any type of mass use suitable controls must be employed and that such were not available in the 1953 mass field applications. Therefore, it is concluded that no obvious or measurable effect of gamma globulin has been demonstrated. With this I am in complete agreement. However, I am not certain that the report emphasizes adequately that the analysis also fails entirely to show that gamma globulin did not have the effect to be expected on the basis of the experimental field trials. These effects were limited largely to a period of 4 to 6 weeks, beginning 1 week after injections were administered. However, the *dramatic* effects anticipated by *some* were *not* observed: that epidemics would be stopped completely, or shortened, or that the incidence curve was affected to the degree observed in institutional outbreaks of measles or hepatitis. No one understanding the very limited effect of gamma globulin as used in general practice, which we have attempted to point out so carefully in several publications, (*4–6*) would have expected obvious or dramatic changes.

It needs to be pointed out, furthermore, that the 1953 experience, even if it had been carried out as an *experiment with suitable controls*, probably would have led to less information than was obtained in the studies of 1951 and 1952 and may very well have failed to afford enough data on which to base any valid conclusion. In all of the mass inoculation areas of 1953, only 43 paralytic cases occurred in the inoculated age groups during the period 2 to 6 weeks after gamma globulin was given and only 104 in all ages. Furthermore, these paralytic cases were scattered through 15 small epidemics. Not one paralytic case in the injected age group occurred in the critical time period in 8 areas where mass inoculations were given.

Not even one large outbreak was included in the 1953 experience, so possible comparisons for shapes of epidemic curves, shifts in age trends, and so forth, could not be made without combining data in such ways as not to be acceptable for drawing valid conclusions.

In respect to mass inoculations, one can conclude only that the 1953 usage was not an experiment, and both the lack of controls and the extremely small number of cases in the critical time period render the data entirely unsuitable for analysis.

When it comes to the section dealing with the inoculation of family contacts the problem is somewhat different. First, let us consider the question of prevention. No data were collected for analysis to determine the comparative incidence of disease in families given gamma globulin after the onset of an index case and in those not given it. Only families in which subsequent cases *did* occur were included in the data and the subsequent cases occurring in these families cannot even be separated into families that did and did not receive the agent. Obviously, any analysis of such data is fruitless for obtaining any answer to the question of prevention.

Insofar as modification of cases is concerned,

although again no scientifically selected controls were available, a comparison was made of patients who failed to receive gamma globulin with those who did receive gamma globulin before onset at various intervals, or after. Why the uninjected did not receive the agent was not determined. Some came from families in which gamma globulin was eventually given and some from families where none was given. From which type of family any given case came is not known. The data which were cumulated for analysis came from 32 different States during a time period June 1 through October 31. It would be surprising if virus strains producing more or less severe disease did not appear in certain areas and at certain time periods during the season. For these and other possible reasons we do not consider these cases sufficiently comparable to be combined for such an analysis. If these cases are accepted as entirely comparable, the differences in severity shown are not significant. However, since the two groups were not scientifically selected and matched for comparative purposes they cannot be considered comparable any more than in any other comparisons that were attempted, and the validity of which was questioned. Therefore, I do not agree that the data presented demonstrate that modification of paralysis did *not* occur.

I agree, however, that the data on modification from the 1951–52 experiments does not warrant the conclusions that were drawn in respect to modification. The differences in severity in 12 cases with onset during the first week after gamma globulin compared to 16 receiving gelatin were statistically valid but we could not exclude to a reasonable degree the possibility that there might be some unrecognized errors or bias in the data, in addition to chance variation. I, therefore, am inclined to revise my previous definite conclusions in respect to modification, but maintain that the issue has not been determined by the present study and cannot be clarified until a larger, suitably controlled experiment has been done. It needs also to be pointed out that the 1951–52 studies were not made on family contacts of index cases, where all contacts can be presumed to have been infected prior to receiving gamma globulin. It is quite possible that to effect either modification or prevention under these special circumstances larger doses of gamma globulin would be required.

In conclusion, the data presented in this report deals with 23 *small* epidemics in most of which gamma globulin was given far too late to be expected to have much or any effect. The data are not from an experiment set up with suitably chosen controls. Analysis of such data (as should have been expected beforehand and was by many) fails to demonstrate whether gamma globulin was or was not effective in the two types of usage to which it was put. It does show clearly, however, as we have attempted to predict previously (4–6), that this agent has an extremely limited application in the field of preventive medicine and will not produce dramatic results in general use.

## REFERENCES


(*1*) Hammon, W. McD., Coriell, L. L., and Stokes, J., Jr.: Evaluation of Red Cross gamma globulin as a prophylactic agent for poliomyelitis. 1. Plan of controlled field test and results of 1951 pilot study in Utah. J. A. M. A. 150: 739–750 (1952).

(*2*) Hammon. W. McD., Coriell, L. L., and Stokes J., Jr.: Evaluation of Red Cross gamma globulin as a prophylactic agent for poliomyelitis. 2. Conduct and early follow-up of 1952 Texas and Iowa-Nebraska studies. J. A. M. A. 150: 750–756 (1952).

(*3*) Hammon, W. McD., Coriell, L. L., Wehrle, P. F., Klimt, C. R., Stokes, J. Jr.: Evaluation of Red Cross gamma globulin as a prophylactic agent for poliomyelitis. 3. Preliminary report of results on clinical diagnoses. J. A. M. A. 150: 757–760 (1952).

(*4*) Hammon, W. McD., Coriell, L. L., Wehrle, P. F., and Stokes, J., Jr.: Evaluation of Red Cross gamma globulin as a prophylactic agent for poliomyelitis. 4. Final report of results based on clinical diagnoses. J. A. M. A. 151; 1272–1285 (1953).

(*5*) Hammon, W. McD.: Limitations in the use of gamma globulin in poliomyelitis. Am. J. Med. Sc. 226: 125–130 (1953).

(*6*) Hammon, W. McD.: Passive immunization against poliomyelitis with especial consideration of the effectiveness of gamma globulin. Bull. New York Acad. Med. 29 (12): 930–942 (1953).

# List of Participating Field Personnel

| STATE | Director of Program in State Health Department | Communicable Disease Center personnel assigned or available | Physical therapists |
|---|---|---|---|
| Alabama | Dr. D. G. Gill<br>*State Health Officer* | Grace I. Larsen<br>*Nurse Epidemiologist* | Eleanore Malone [1] |
| Arkansas | Dr. J. T. Herron<br>*State Health Officer* | Dr. M. L. Furcolow [1 2]<br>*Officer in charge* | Jean Bailey [1] |
| California | Dr. A. C. Hollister, Jr.<br>*Chief, Acute Communicable Disease Service* | Dr. Charles I. Leftwich<br>*EIS[3] Officer* | Georgianna Harmon |
| Los Angeles | Dr. John M. Chapman<br>*Assistant Medical Director and Epidemiologist* | Dr. Charles I. Leftwich<br>*EIS Officer* | Nina Haugen |
| Colorado | Dr. R. L. Cleere<br>*Executive Director* | Dr. Julius Amer<br>*EIS Officer* | Eleanor J. Westcott |
| Connecticut | Dr. James C. Hart<br>*Director, Bureau of Preventable Diseases* | Dr. Edward I. Honig [1]<br>*EIS Officer* | Phyllis B. Johnson |
| Delaware | Dr. F. I. Hudson<br>*Executive Secretary* | | Paul G. O'Connor |
| District of Columbia | Dr. John R. Pate<br>*Director, Bureau of Preventable Diseases* | Dr. Sheldon Kravitz [1]<br>*EIS Officer* | Jean M. McDermott |
| Florida | Dr. L. L. Parks<br>*Director, Bureau of Preventable Diseases* | Dr. Carl P. Bernet, Jr.<br>*EIS Officer* | Mabel Parker |
| Georgia | Dr. W. J. Murphy<br>*Director, Division of Epidemiology* | Lillian S. Dick<br>*Nurse Epidemiologist* | Eleanore Malone |
| Idaho | Mr. L. J. Peterson<br>*Administrative Director* | Dr. Gerald D. LaVeck [1]<br>*EIS Officer* | Anna Sweeley |
| Illinois | Dr. Leonard M. Schuman<br>*Deputy Director, Division of Preventive Medicine* | Dr. Robert Mellins<br>*EIS Officer* | Mary A. Gaughan<br>Minna Hildebrand<br>Myrtle E. Swanson |
| Iowa | Dr. Edmund G. Zimmerer<br>*Commissioner* | Dr. M. L. Furcolow<br>*Officer in Charge [1 2]* | Jean Bailey [1] |
| Kansas | Dr. Thomas R. Hood<br>*Executive Secretary* | Dr. M. L. Furcolow<br>*Officer in Charge [2]* | Jean Bailey |
| Kentucky | Dr. B. M. Drake<br>*Deputy Commissioner in Charge of Preventive Medical Services* | | Irene Coons<br>Irene Schafer |

See footnotes at end of table.

| STATE | Director of Program in State Health Department | Communicable Disease Center personnel assigned or available | Physical therapists |
|---|---|---|---|
| Louisiana | Dr. Andrew Hedmeg<br>*Director of Preventive Medicine* | Mary E. O'Connor<br>*Nurse Epidemiologist* | Eleanore Malone [1] |
| Maine | Dr. Dean Fisher<br>*Director of Health* | Dr. Edward I. Honig [1] | Margaret S. Arey [1] |
| Maryland | Dr. Perry F. Prather<br>*Deputy Director* | Dr. Sheldon Kravitz<br>*EIS Officer, CDCA* [4] | Elma Lee Georg |
| Massachusetts | Dr. Roy F. Feemster<br>*Director, Division of Communicable Diseases* | Dr. Edward I. Honig [1]<br>*EIS Officer* | Margaret S. Arey |
| Michigan | Dr. Albert E. Heustis<br>*Commissioner of Health* | | Sue D. Brook<br>Esther B. Hart<br>Hildegarde Kummer |
| Minnesota | Dr. A. J. Chesley<br>*Secretary and Executive Officer* | | Alice Chesrown |
| Mississippi | Dr. Archie L. Gray<br>*State Epidemiologist* | Albina Bozym<br>*Nurse Epidemiologist* | Eleanore Malone [1] |
| Missouri | Dr. E. A. Belden<br>*Director, Bureau of Communicable Diseases* | Dr. M. L. Furcolow<br>*Officer in Charge* [1 2] | Jean Bailey [1] |
| Nebraska | Dr. E. A. Rogers<br>*Acting Director of Health* | Dr. M. L. Furcolow<br>*Officer in Charge* [1 2] | Jean Bailey [1] |
| Nevada | Dr. Daniel J. Hurley<br>*Acting State Health Officer* | | Marion Barfknecht |
| New Hampshire | Dr. Clifford W. Wells<br>*Director, Communicable Disease Control* | Dr. Edward I. Honig [1]<br>*EIS Officer* | Margaret S. Arey [1] |
| New York | Dr. Robert F. Korns<br>*State Epidemiologist* | Dr. Ernest Kane<br>*EIS Officer, CDCA* | Louise Hayward<br>Edith B. Nichols<br>Winifred L. Rumsey |
| New York City | Dr. Morris Greenberg | | Helen Antman |
| North Carolina | Dr. J. W. R. Norton<br>*State Health Officer* | Dr. Jesse G. Smith<br>*EIS Officer, CDCA* | Celeste A. Hayden |
| North Dakota | Jerome H. Svore<br>*Director of Public Health* | Dr. M. L. Furcolow<br>*Officer in Charge* [1 2] | Jean Bailey [1] |
| Ohio | Dr. Frederick Wentworth<br>*Chief, Division of Communicable Diseases* | Dr. Reimert Ravenholt<br>Dr. Martin Keller<br>*EIS Officers, CDCA* | Ruth E. Pratt |
| Oklahoma | Dr. G. F. Mathews<br>*Commissioner of Health* | Dr. M. L. Furcolow<br>*Officer in Charge* [1 2] | Mary E. Rexroad |
| Oregon | Dr. Harold M. Erickson<br>*State Health Officer* | Dr. Gerald LaVeck [1]<br>*EIS Officer, CDCA* | Elizabeth Fellows |
| Pennsylvania | Dr. M. C. Stayer<br>*Director, Division of Preventive Services* | | Mary Elizabeth Kolb<br>Miriam Jacobs |
| Rhode Island | Dr. Edward A. McLaughlin<br>*Director of Health* | Dr. Edward I. Honig [1]<br>*EIS Officer* | |
| South Carolina | Dr. G. E. McDaniel<br>*Director, Division of Disease Control* | Phyllis B. Hullum<br>*Nurse Epidemiologist* | Celeste A. Hayden [1] |

See footnotes at end of table.

| STATE | Director of Program in State Health Department | Communicable Disease Center personnel assigned or available | Physical therapists |
|---|---|---|---|
| Tennessee | Dr. Cecil B. Tucker<br>*Director, Division of Preventive Diseases* | Mary S. Romer<br>*Nurse Epidemiologist* | Deborah Kinsman |
| Texas | Dr. George W. Cox<br>*State Health Officer* | Dr. Gordon W. Grace<br>*EIS Officer* | Carmella Gonnella |
| Utah | Dr. A. A. Jenkins<br>*Director, Division of Disease Control* | Dr. Garth G. Myers<br>*EIS Officer, CDCA* | Helen Blood |
| Vermont | Dr. Maynard H. Mires<br>*Director, Communicable Disease Control* | Dr. Edward I. Honig [1]<br>*EIS Officer* | Margaret S. Arey [1] |
| Virginia | Dr. Mack I. Shanholtz<br>*State Health Commissioner* | | |
| Washington | Dr. J. A. Kahl<br>*Acting Director* | Dr. Gerald D. LaVeck<br>*EIS Officer, CDCA* | Carolyn Bowen |
| West Virginia | Dr. N. H. Dyer<br>*State Director of Health* | | |
| Wisconsin | Dr. Milton Feig<br>*Director, Section on Preventable Diseases* | | Lillie M. Bachanz<br>Alfaretta Wright |

[1] Serving this State but assigned elsewhere.

[2] The following CDC personnel are members of the epidemiologic team at Kansas City Field Station, of which Dr. M. L. Furcolow is officer in charge: Dr. Lee D. Cady, Jr., EIS officer; Dr. Philip Danufsky, EIS officer; Dr. John W. Doss, EIS officer; Jennie H. Rakich, nurse officer epidemiologist; and David Sachs, statistician.

[3] Epidemic Intelligence Service.

[4] Communicable Disease Center Activities.

NOTE: The following E. I. S. Officers were assigned to the National Evaluation Center, CDC, Atlanta, Ga., and were available for mobile field service to epidemic areas: Dr. Martin Keller, Dr. Martin Hicklin.

*Appendix B*

# Reports of Epidemiologic Investigations In Thirteen Mass Inoculation Areas, 1953

## Poliomyelitis Epidemic Areas Investigated in 1953 And Communicable Disease Center Personnel Assigned to Investigations

*Montgomery County, Ala.*
Martin Hicklin, M. D., David Sachs, M. A., and Grace Larsen, R. N.

*Caldwell County, N. C.*
Harold Black, M. S., Heinz Eichenwald, M. D., J. Graham Smith, M. D., Martin Keller, M. D., and L. Dorothy Carroll, R. N.

*Catawba County, N. C.*
Harold Black, M. S., Heinz Eichenwald, M. D., J. Graham Smith, M. D., Martin Keller, M. D., and L. Dorothy Carroll, R. N.

*Washington County, Va., Sullivan County, Tenn., and Bristol City, Va.-Tenn.*
Heinz Eichenwald, M. D., and Martin Keller, M. D.

*Carter County, Tenn.*
Martin Keller, M. D., and Heinz Eichenwald, M. D.

*Avery County, N. C.*
J. Graham Smith, M. D., Heinz Eichenwald, M. D., Harold Black, M. S., and Martin Keller, M. D.

*Smyth County, Va.*
Martin Keller, M. D., and Heinz Eichenwald, M. D.

*Stearns, Benton, and Meeker Counties, Minn.*
Ira Myers, M. D.

*Monroe County, Fla.*
Carl P. Bernet, M. D.

# Montgomery County, Alabama

On June 22, 1953, Dr. D. G. Gill, State health officer of Alabama, requested the services of an epidemiologic team from the Communicable Disease Center to assist in an investigation of an outbreak of poliomyelitis in Montgomery County, Ala. A team composed of Dr. Martin Hicklin, Epidemic Intelligence Service (EIS), officer in charge, Grace Larsen, nurse officer epidemiologist, and David Sachs, statistician, was promptly assigned to Dr. Gill for the investigation, which began June 23, and continued periodically until September 30. The team was assigned by Dr. Gill to Dr. A. H. Graham, Montgomery County health officer, and headquarters were provided in the county health department. Later in the study physical therapy consultation was provided by Mrs. Eleanore Malone, physical therapist, assigned to the National Gamma Globulin Evaluation Center.

One hundred and nine cases of frank poliomyelitis and 11 cases of suspected poliomyelitis were included in the study, and 74 percent of these were regarded as paralytic. There were 6 deaths. The attack rate for the period of study, based on 1950 census figures, was 86 per 100,000 population. The case fatality rate was 5 percent.

## Area and Poliomyelitis History

Montgomery County is located in central Alabama. The population of the county in the 1950 census enumeration was 138,965, with 44 percent nonwhite. The city of Montgomery, the capital of the State, located in the northwest part of the county, had a population of 106,525 in the last census, with 40 percent nonwhite. During the 10-year period, 1940–50, the city of Montgomery showed a 36.4-percent increase in population, while the county as a whole increased 21.5 percent.

During the 5-year period, 1948–52, the county recorded a total of 119 cases of poliomyelitis, practically all of them paralytic. Nonparalytic cases were for the most part not recorded. The largest previous outbreak occurred in 1949, when 54 cases were reported. Annual incidence for the years 1948–52 is shown in table 1.

## Reporting, Diagnosis, and Hospitalization

Cases were reported by physicians by telephone directly to the county health officer, giving the name, age, sex, color, address, date of onset, type of involvement, whether paralytic or nonparalytic at the time of report, and place where hospitalized. The diagnosis was regarded as confirmed if there was an increase in the cerebral spinal fluid cells or if there were definite signs of muscle involvement. In addition, each reported case was confirmed by the examination of at least one other physician chosen from a panel of pediatricians and orthopedists designated by the county medical society. No charge was made to the patient for this service. This consultation was requested by the county health officer in order to maintain a critical level of diagnosis so as to conserve gamma globulin for family contacts. Following the report of a confirmed case, a county public health nurse visited the home to obtain routine epidemiologic information, including a household roster, and to give gamma globulin to contacts. Additional clinical information was secured from hospital records and from the attending physician.

**Table 1. Recorded cases of poliomyelitis, Montgomery County, Ala., 1948–52** [1]

| *Year* | *Number of cases* |
|---|---|
| 1948 | 1 |
| 1949 | 54 |
| 1950 | 20 |
| 1951 | 16 |
| 1952 | 28 |

[1] These cases are not designated as to the status of paralysis but in practically all instances recording has been limited to paralytic cases.

The largest number of patients was hospitalized at Saint Jude's Hospital; a few private patients were hospitalized at Jackson Hospital, a smaller and private institution where no respirators were available. Maxwell Air Force Base Hospital provided isolation and physical ther-

Figure 1A. Total weekly poliomyelitis incidence rates per 100,000 population, Montgomery County, Ala., 1953, by week of report, and paralytic status of cases, by week of onset.

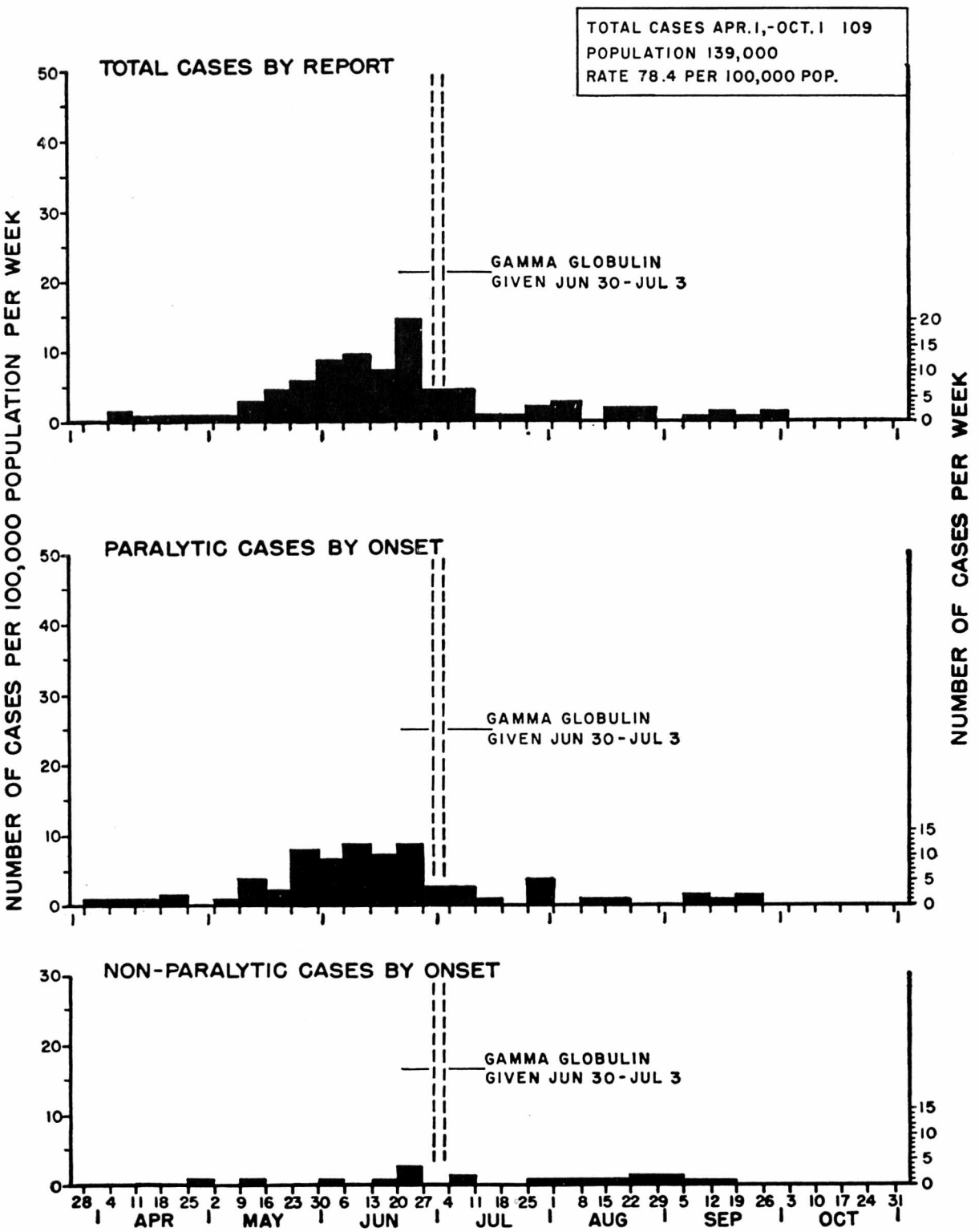
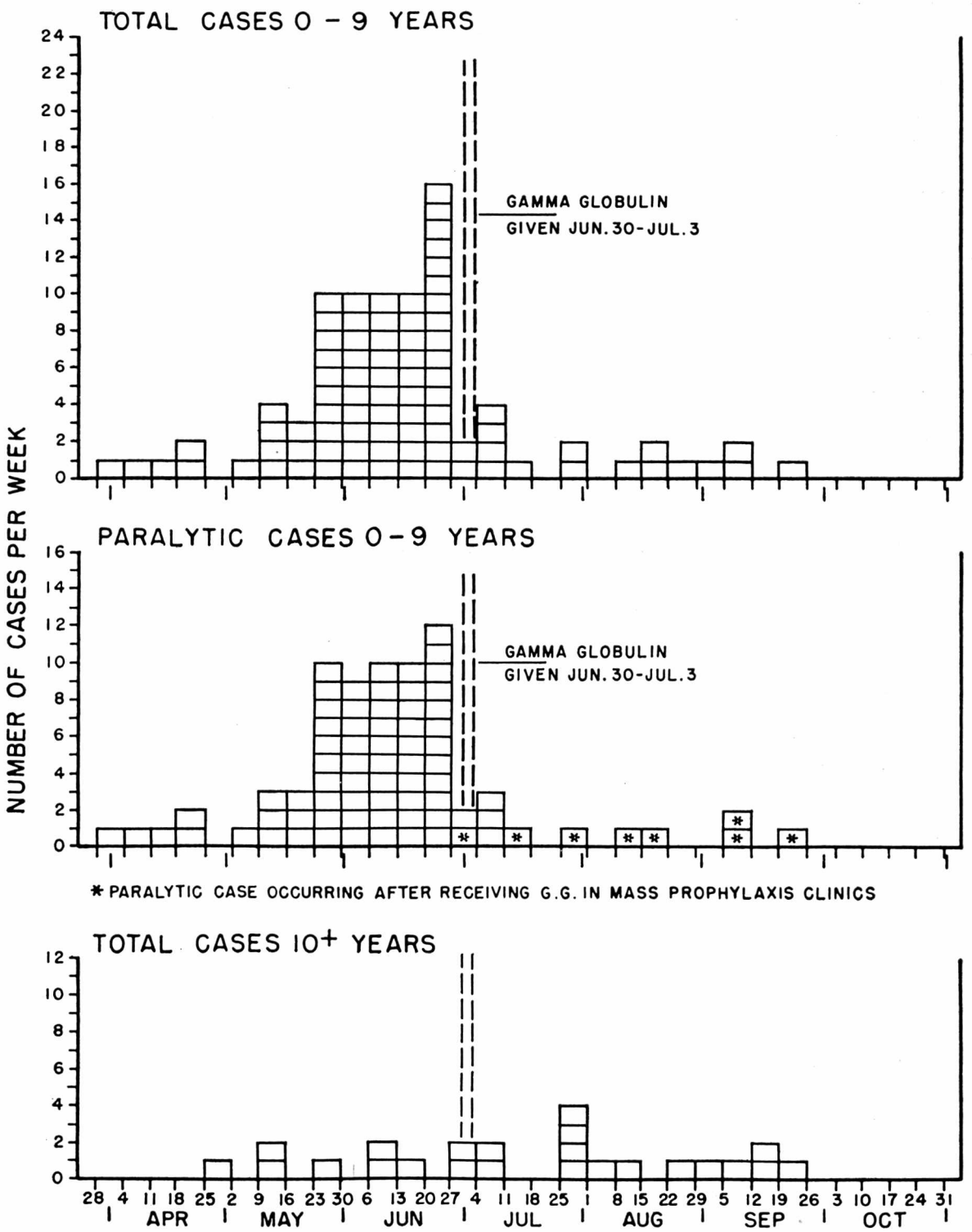


Figure 1B. Number of cases of poliomyelitis, Montgomery County, Ala., 1953, by week of onset, age group, and paralytic status.





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apy for those patients who were dependents of military personnel; only one of the cases occurring locally had been hospitalized elsewhere than in these three institutions. Four patients who resided in Montgomery but whose onset occurred elsewhere were included among total cases. (The onset of these cases was 1, 3, 7, and 9 days after departing from Montgomery.)

## Administration of Gamma Globulin

Gamma globulin was available for all household contacts under 30 years of age and for pregnant women of any age who were contacts. The injections were administered by the nursing staff of the county health department during working hours or by the staff of Saint Jude's Hospital during evenings and weekends. Contacts who were dependents of Air Force personnel living at Maxwell Field were inoculated at the base hospital. Injections were generally given very promptly, either the same day the report was received or early the following day. The gamma globulin request form listed all contacts who were to receive injections, their age, the dosage, and the date of administration.

As the result of a rising incidence of reported cases, the county was certified for community prophylaxis on June 26. Gamma globulin was made available for all children 9 years of age and under, since this age group represented 88

**Table 2A. Distribution of cases of poliomyelitis, by week of onset by status of paralysis[1] and age group, April 1 to September 30, 1953, Montgomery County, Ala.**

| Week of onset | Age (years) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0–9 | | | | 10 and over | | | | All ages | | | |
| | P | NP | S | Total | P | NP | S | Total | P | NP | S | Total |
| March 29–April 4 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| April 5–April 11 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| April 12–April 18 | 1 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 |
| April 19–April 25 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 |
| April 26–May 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| May 3–May 9 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| May 10–May 16 | 3 | 1 | 1 | 5 | 2 | 0 | 0 | 2 | 5 | 1 | 1 | 7 |
| May 17–May 23 | 3 | 0 | 0 | 3 | 0 | 0 | 1 | 1 | 3 | 0 | 1 | 4 |
| May 24–May 30 | 10 | 0 | 0 | 10 | 1 | 0 | 0 | 1 | 11 | 0 | 0 | 11 |
| May 31–June 6 | 9 | 1 | 1 | 11 | 0 | 0 | 0 | 0 | 9 | 1 | 1 | 11 |
| June 7–June 13 | 10 | 0 | 0 | 10 | 2 | 0 | 0 | 2 | 12 | 0 | 0 | 12 |
| June 14–June 20 | 10 | 0 | 0 | 10 | 0 | 1 | 1 | 2 | 10 | 1 | 1 | 12 |
| June 21–June 27 | 12 | 4 | 0 | 16 | 0 | 0 | 0 | 0 | 12 | 4 | 0 | 16 |
| June 28–July 4 | 2 | 0 | 2 | 4 | 2 | 0 | 0 | 2 | 4 | 0 | 2 | 6 |
| July 5–July 11 | 3 | 1 | 0 | 4 | 1 | 1 | 1 | 3 | 4 | 2 | 1 | 7 |
| July 12–July 18 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| July 19–July 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| July 26–August 1 | 1 | 1 | 0 | 2 | 4 | 0 | 0 | 4 | 5 | 1 | 0 | 6 |
| August 2–August 8 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| August 9–August 15 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 2 |
| August 16–August 22 | 1 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 2 |
| August 23–August 29 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 2 | 0 | 2 | 1 | 3 |
| August 30–September 5 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 2 | 0 | 2 |
| September 6–September 12 | 2 | 0 | 0 | 2 | 0 | 1 | 1 | 2 | 2 | 1 | 1 | 4 |
| September 13–September 19 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 2 | 1 | 1 | 1 | 3 |
| September 20–September 26 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 2 | 0 | 0 | 2 |
| September 27–October 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 75 | 11 | 6 | 92 | 14 | 9 | 5 | 28 | 89 | 20 | 11 | 120 |

[1] S=Suspect case (no paralysis, and spinal fluid either normal or not examined); P=paralytic; NP=non-paralytic, based on physical therapist's examination 50–70 days after onset; the only cases omitted from this examination were those reportedly paralytic cases with onset prior to June 23, 1953, and the 2 who could not be located.

**Table 2B. Distribution of cases of poliomyelitis, by week of report and by status of paralysis,[1] Montgomery County, Ala., April 1–September 30, 1953**

| Week of report | P | NP | S | Total |
|---|---|---|---|---|
| March 29–April 4 | 0 | 0 | 0 | 0 |
| April 5–April 11 | 0 | 0 | 0 | 0 |
| April 12–April 18 | 2 | 0 | 0 | 2 |
| April 19–April 25 | 1 | 0 | 1 | 2 |
| April 26–May 2 | 1 | 0 | 0 | 1 |
| May 3–May 9 | 0 | 0 | 0 | 0 |
| May 10–May 16 | 1 | 1 | 0 | 2 |
| May 17–May 23 | 3 | 0 | 0 | 3 |
| May 24–May 30 | 8 | 0 | 0 | 8 |
| May 31–June 6 | 7 | 1 | 0 | 8 |
| June 7–June 13 | 9 | 0 | 1 | 10 |
| June 14–June 20 | 9 | 1 | 0 | 10 |
| June 21–June 27 | 16 | 3 | 1 | 20 |
| June 28–July 4 | 9 | 0 | 0 | 9 |
| July 5–July 11 | 1 | 2 | 2 | 5 |
| July 12–July 18 | 1 | 0 | 1 | 2 |
| July 19–July 25 | 2 | 0 | 0 | 2 |
| July 26–Aug. 1 | 5 | 0 | 0 | 5 |
| Aug. 2–Aug. 8 | 0 | 2 | 0 | 2 |
| Aug. 9–Aug. 15 | 0 | 0 | 0 | 0 |
| Aug. 16–Aug. 22 | 2 | 2 | 0 | 4 |
| Aug. 23–Aug. 29 | 0 | 2 | 1 | 3 |
| Aug. 30–Sept. 5 | 0 | 1 | 0 | 1 |
| Sept. 6–Sept. 12 | 1 | 2 | 0 | 3 |
| Sept. 13–Sept. 19 | 1 | 1 | 0 | 2 |
| Sept. 20–Sept. 26 | 1 | 0 | 1 | 2 |
| Sept. 27–Oct. 3 | 1 | 0 | 0 | 1 |
| No date given | 8 | 2 | 3 | 13 |

P=paralytic; NP=nonparalytic; S=suspect case.
[1] See footnote, table 2A.

percent of the cases at the time of certification. There were an estimated 29,600 individuals in this age group.

Gamma globulin was given during a 4-day period, beginning June 30 and ending on July 3, in Montgomery city and for a 2-day period, July 2 and 3, for the county area. A total of 32,955 injections was administered during this period.

## Epidemiologic Investigation

From June 24 through September 30, a household visit was made to every reported case of poliomyelitis, and information for the completion of the case investigation form (PHS Form 400.88A) was sought by personal interview of parents or other adult household members. Hospital records were reviewed and physicians and physical therapists were queried in order to obtain the necessary clinical data. These data were completed for all but one case.

As a part of the study, a physical therapist examined all patients designated as other than paralytic (nonparalytic and suspected cases), whose onset fell between April 1 and June 23, in order to detect slight muscle involvements. In addition, all surviving patients who were members of multiple-case households were examined and the degree of residual paralysis quantitated at a time 50 to 70 days after onset. An attempt was made to secure this same examination on all cases occurring after June 23; only two cases in this group were not examined.

In the following analysis the status of paralysis is based, whenever possible, on the results of this examination by the physical therapist. In 21 instances this resulted in the discovery of some degree of residual paralysis in a patient previously designated "suspect" or "nonparalytic." In no instance was there failure to find "paralytic involvement in a case already designated paralytic."

### *Distribution of Cases in Time*

Between April 1 and September 30, 1953, 109 cases of frank poliomyelitis and 11 suspected cases of poliomyelitis occurred, giving a total attack rate of 86 per 100,000 population, 1950 census. These cases are tabulated in tables 2A and 2B, by week of onset and by week of report for status of paralysis and for total cases. The outbreak appears to have begun early in April, with a progressive rise to epidemic proportions beginning in mid-May and reaching a peak in late June for both paralytic cases and total cases. Many of the cases subsequently found to be paralytic during the third and fourth weeks of June previously had been reported as nonparalytic.

### *Distribution of Cases by Age, Race, and Residence*

The age and race specific attack rates are presented in tables 3A and 3B, for all reported cases and for paralytic cases only. The highest rate for the nonwhites was in the 1–4-age group while the highest rate of attack for the whites was in the 5–9-age group. This age differential, with regard to race, was true for both total cases and paralytic cases.

The attack rates according to area of residence within the county are presented in table 4. The total attack rate for the city of Montgomery was 89 per 100,000 population as com-

**Table 3A. Number of paralytic and total cases of poliomyelitis by age and race, Montgomery County, Ala. April 1–September 30, 1953**

| Age group | 1950 population | | | Paralytic cases | | | Total cases [1] | | |
|---|---|---|---|---|---|---|---|---|---|
| | White | Non-white | Total | White | Non-white | Total | White | Non-white | Total |
| <1 year | 1, 858 | 1, 490 | 3, 348 | 1 | 1 | 2 | 1 | 1 | 2 |
| 1–4 years | 7, 297 | 6, 149 | 13, 446 | 6 | 22 | 28 | 10 | 25 | 35 |
| 5–9 years | 6, 502 | 6, 128 | 12, 630 | 30 | 15 | 45 | 40 | 15 | 55 |
| 10–14 years | 4, 749 | 5, 637 | 10, 386 | 4 | 2 | 6 | 10 | 6 | 16 |
| 15 years and over | 57, 943 | 41, 212 | 99, 155 | 7 | 1 | 8 | 9 | 3 | 12 |
| All ages | 78, 349 | 60, 616 | 138, 965 | 48 | 41 | 89 | 70 | 50 | 120 |

[1] Includes nonparalytic and suspect cases. (See footnote, table 2A.)

**Table 3B. Age-specific attack rates, by race, cases per 100,000 population**

| Age group | Paralytic cases | | | Total cases [1] | | |
|---|---|---|---|---|---|---|
| | White | Nonwhite | Total | White | Nonwhite | Total |
| <1 year | 54 | 67 | 60 | 54 | 67 | 60 |
| 1–4 years | 82 | 358 | 208 | 137 | 407 | 260 |
| 5–9 years | 462 | 245 | 356 | 615 | 245 | 435 |
| 10–14 years | 84 | 35 | 58 | 211 | 106 | 154 |
| 15 years and over | 12 | 2 | 8 | 15 | 7 | 12 |
| All ages | 61 | 67 | 64 | 90 | 82 | 86 |

[1] Includes nonparalytic and suspect cases. (See footnote, table 2A.)

**Table 4. Attack rate of poliomyelitis, according to area of residence, Montgomery County, Ala., April 1–September 30, 1953**

| Location | 1950 population | Total cases [1] | | Paralytic cases | |
|---|---|---|---|---|---|
| | | Number of cases | Attack rate per 100,000 population | Number of cases | Attack rate per 100,000 population |
| Montgomery County | 138, 965 | 120 | 86 | 89 | 64 |
| Rural | 32, 440 | 25 | 77 | 19 | 59 |
| City of Montgomery | 106, 525 | 95 | 89 | 70 | 66 |
| Beat 1 | 12, 222 | 18 | 147 | 12 | 98 |
| Beat 2 | 27, 582 | 26 | 94 | 25 | 91 |
| Beat 3 | 10, 884 | 18 | 165 | 14 | 129 |
| Beat 4 | 7, 211 | 2 | 28 | 1 | 14 |
| Beat 5 | 13, 658 | 12 | 88 | 8 | 59 |
| Beat 6 | 11, 097 | 2 | 18 | 1 | 9 |
| Beat 7 | 17, 206 | 7 | 41 | 1 | 6 |
| Beat 23 | 6, 665 | 10 | 150 | 8 | 120 |

[1] See footnote, table 3.

**Table 5. Interval in days between onset of index cases and subsequent cases of poliomyelitis in multiple-case households, Montgomery County, Ala., April 1–September 30, 1953**

| Interval (days) | Number of cases [1] | | | |
|---|---|---|---|---|
| | P | NP | S | Total |
| 0 | 1 | 1 | 0 | 2 |
| 1 | 2 | 2 | 0 | 4 |
| 2 | 1 | 0 | 0 | 1 |
| 3 | 1 | 0 | 0 | 1 |
| 4 | 0 | 0 | 0 | 0 |
| 5 | 4 | 0 | 0 | 4 |
| 6 | 2 | 0 | 0 | 2 |
| 7 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 |
| 9 | 1 | 0 | 0 | 1 |
| 10 | 0 | 0 | 0 | 0 |
| 11 | 0 | 0 | 0 | 0 |
| 12 | 0 | 0 | 1 | 1 |
| Total | 12 | 3 | 1 | 16 |

P=paralytic; NP=nonparalytic; S=suspect case.

[1] See footnote, table 2A.

pared to 77 per 100,000 population for the rural portion of the county. If only paralytic cases are considered, attack rates are 66 per 100,000 population, as compared to 59 per 100,000 population, respectively. The attack rate for the southwestern half of the city (beats 1, 2, 3, and 23) appeared to be higher than those for the northeastern half of the city. When paralytic cases are considered alone, these differences are accentuated. The northeastern portion of the city consists of middle-class families, while the southwestern half of the city consists of one area of lower-income groups and another area of upper-income groups, in addition to the area (beat 1) that is predominately inhabited by Maxwell Air Force personnel. Evidence of radial spread was not apparent.

### *Familial Aggregation*

Fourteen multiple-case households were reported during the period of study, 12 households with 2 cases each and 2 households with 3 cases each. Thus, 14 households accounted for 30 of the 120 cases. The interval between the onset of the first and subsequent cases in these households is shown in table 5. Twelve of these subsequent cases became ill within 5 days after onset of the index case, while the other 4 had become ill within 6 to 12 days. The age-specific subsequent attack rates are presented in table 6. The total subsequent attack rate is 3,279 per 100,000 population with the highest rate of 9,589 per 100,000 being in the age group 5–9. If consideration is limited to paralytic cases, the total secondary attack rate is 2,459 per 100,000, since 12 of the subsequent cases were paralytic (75 percent).

Only 6 of the subsequent cases (table 7) received gamma globulin prior to the onset of their illnesses. The intervals between injection and onset in these cases were: same day, 1 case; 2 days, 2 cases; 3 days, 1 case, and 5 days, 1 case. The other case had received gamma globulin 47 days prior to onset through the mass inoculation program. All except this latter case were paralytic, four mildly paralytic, and one with considerable involvement. Of the 10 subsequent cases which did not receive gamma globulin, 7 were paralytic, 2 nonparalytic, and 1 suspect.

## Summary

A description of an epidemic of 109 frank and 11 suspected cases of poliomyelitis occurring in Montgomery County, Ala., with onsets between April 1 and October 1, 1953, is presented. The total attack rate for the county was 86 per 100,000, and the city of Montgomery had an attack rate of 89 per 100,000 population. The peak of the distribution fell during the week ending June 27. On June 30 and July 1, 2, and 3, gamma globulin was administered to 32,955 children under age 10 in the mass prophylaxis program. Though there was a higher proportion of total cases in the older age groups in the period following the mass prophylaxis (table 8), this in itself is insufficient evidence to conclude that the mass prophylaxis altered the course of the epidemic.

**Table 6. Age-specific subsequent attack rates of poliomyelitis, Montgomery County, Ala., April 1–September 30, 1953**

| Age group | Number of household contacts of index cases | Subsequent cases [1] | | | | Subsequent attack rate [1] | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | P | NP | S | Total | P | NP | S | Total |
| <5 years | 81 | 3 | 3 | 0 | 6 | 3, 704 | 3, 704 | 0 | 7, 407 |
| 5–9 years | 73 | 7 | 0 | 0 | 7 | 9, 589 | 0 | 0 | 9, 589 |
| 10 years and over | 334 | 2 | 0 | 1 | 3 | 599 | 0 | 299 | 898 |
| All ages | 488 | 12 | 3 | 1 | 16 | 2, 459 | 615 | 205 | 3, 279 |

P=paralytic; NP=nonparalytic; S=suspect case.

[1] See footnote, table 2A.

**Table 7. Summary of subsequent cases of poliomyelitis in multiple-case households, Montgomery County, Ala., April 1–September 30, 1953**

| Case No. | Household No. | Date of onset | Age | Interval from index case (days) | Paralytic status [1] | Percent paralytic status [2] | Interval, gamma globulin to onset (days) |
|---|---|---|---|---|---|---|---|
| | A. Those receiving gamma globulin | | | | | | |
| 38 | II | June 8 | 9 | 5 | P | 1. 3 | 2 |
| 55 | V | June 18 | 6 | 5 | P | 2. 8 | 3 |
| 77 | X | June 24 | 6 | 2 | P | 1. 27 | 0 |
| 102 | XII | July 8 | 2 | 3 | P | 28. 9 | 2 |
| 107 | XIII | Aug 18 | 2 | 1 | NP | 0 | [3] 47 |
| Unnumbered | XIV | May 30 | 6 | 5 | P | 1. 5 | 5 |
| | B. Those not receiving gamma globulin | | | | | | |
| 8 | I | May 12 | 13 | 6 | P | 53. 4 | |
| 13 | I | May 18 | 10 | 12 | S | 0 | |
| 31 | II | June 4 | 2 | 1 | P | 7. 6 | |
| 35 | III | June 5 | 6 | 6 | P | 50. 0 | |
| 42 | IV | June 6 | 6 | [4] 0 | P | 24. 7 | |
| 58 | VI | June 21 | 3 | 1 | NP | 0 | |
| 71 | VII | June 21 | 3 | [4] 0 | NP | 0 | |
| 15 | VIII | May 16 | 5 | 5 | P | 4. 2 | |
| 73 | IX | June 20 | 4 | 1 | P | 9. 6 | |
| 82 | XI | June 29 | 33 | 9 | P | 5. 1 | |

P=paralytic; NP=nonparalytic.

[1] See footnote to table 2A.

[2] Paralytic index is computed from the mass of involved muscles and the degree of paralysis at the time of examination by the physical therapist, 50–70 days after onset, using the method devised by the American Physical Therapy Association and the National Program for the Evaluation of Gamma Globulin in Poliomyelitis.

[3] This case had received gamma globulin only through the mass inoculation, not by virtue of the household contact with the index case. The other cases in this series received gamma globulin by virtue of their household contact with the index case.

[4] These cases had onset on the same date as their index cases and were arbitrarily chosen as subsequent cases because they were reported second. Case No. 42 is subsequent to a paralytic case in a 4-year-old; case No. 71 is subsequent to a nonparalytic case in a 6-year-old.

**Table 8. Summary of all cases of poliomyelitis having onset after the mass inoculation of gamma globulin, Montgomery County, Ala.,[1] June 30–July 3, 1953**

| Case No. | Age | Date of onset | Paralytic status [2] | Paralytic index (percent) [3] | Interval gamma globulin to onset of poliomyelitis (days) |
|---|---|---|---|---|---|
| | A. Cases receiving gamma globulin | | | | |
| 86 | 5 | July 1 | P | not examined | 1 |
| 87 | 6 | July 3 | S | 0 | 3 |
| 90 | 6 | July 1 | S | 0 | [4] |
| 91 | 7 | July 9 | NP | 0 | 9 |
| 94 | 3 | July 13 | P | 74.1 | 11 |
| 95 [5] | 5 | July 5 | P | 31.5 | [4] |
| 97 | 2 | July 26 | P | 5.95 | 25 |
| 102 [5] | 2 | July 8 | P | 28.9 | 2 |
| 103 | 6 | July 29 | NP | 0 | 27 |
| 105 | 3 | Aug 15 | P | 62.6 | 44 |
| 106 | 5 | Aug 17 | P | 15.1 | 46 |
| 107 | 2 | Aug. 18 | NP | 0 | 47 |
| 108 | 7 | Aug. 23 | NP | 0 | 51 |
| 113 | 7 | Sept. 9 | P | 22.3 | 71 |
| 115 | 6 | Sept. 10 | P | 20.4 | 72 |
| 116 [5] | 9 | Sept. 13 | S | 0 | 50 |
| 121 | 2 | Sept. 25 | P | 11.9 | 85 |
| | B. Cases not receiving gamma globulin | | | | |
| 88 | 25 | July 5 | P | 31.3 | |
| 89 | 14 | July . 7. | NP | 0 | |
| 92 | 14 | July 10 | S | 0 | |
| 93 | 1 | July 9 | P | expired | |
| 96 | 16 | July 28 | P | 3.0 | |
| 98 | 28 | July 28 | P | expired | |
| 99 | 29 | July 26 | P | 4.0 | |
| 100 | 11 | July 31 | P | expired | |
| 101 | 10 | Aug. 2 | NP | 0 | |
| 104 | 11 | Aug. 14 | NP | 0 | |
| 109 | 12 | Aug. 27 | S | 0 | |
| 110 | 10 | Aug. 27 | NP | 0 | |
| 111 | 5 | Sept. 4 | NP | 0 | |
| 112 | 15 | Sept. 1 | NP | 0 | |
| 114 | 12 | Sept. 9 | NP | 0 | |
| 117 | 28 | Sept. 13 | P | 96.2 | |
| 118 | 18 | Sept. 17 | NP | 0 | |
| 119 | 11 | Sept. 20 | P | 1.3 | |
| 120 | 27 | Sept. 8 | S | not examined | |

P=paralytic; NP=nonparalytic; S=suspect.

[1] To September 30, 1953. [2] See footnote, table 2A. [3] See footnote 2, table 7. [4] Gamma globulin actually given after onset of symptoms.

[5] These cases received gamma globulin, but not during the mass inoculation. All other cases in this series received gamma globulin through the mass inoculation. Case 116 received only a "small dosage of measles G. G." administered by a private physician.

# Caldwell County, North Carolina

On July 29, 1953, Dr. Fred T. Foard, director, division of epidemiology, North Carolina State Board of Health, requested the services of a team from the Communicable Disease Center to aid in an epidemiologic investigation of an outbreak of poliomyelitis involving Caldwell, Catawba, and Avery Counties. This report deals with the results of the investigations in Caldwell County. At the time of the request, a total of 126 cases had been reported in this county since January 1, 1953. Of these, 37, or 29 percent, were reported as paralytic; 37, or 29 percent, were reported as nonparalytic; and 52, or 42 percent, were unspecified. The total attack rate at that time was 291 per 100,000 population based on 1950 census figures. Up to July 29, there had been 5 deaths, giving a case fatality rate of 4 percent. All the reported cases had been hospitalized.

Under the direction of Dr. J. Graham Smith, Epidemic Intelligence Service officer, assigned to the North Carolina State Board of Health, a team composed of Dr. Martin D. Keller, EIS; Dr. Heinz Eichenwald, EIS; and Harold W. Black, statistician, reported to Dr. William Happer, Caldwell County health officer, on August 3, 1953, to conduct the investigation. The survey work was completed in Caldwell County on August 14, 1953.

## Reporting and Diagnosis

Cases were reported by physicians by telephone directly to the county health officer stating name, age, sex, color, address, date of onset, status of paralysis, and place of hospitalization.

Since all cases were hospitalized, the final diagnosis was based on a report sent by the hospitals to the county health department. No further measures were taken by the county health department to confirm the reporting physician's diagnosis. Most of the cases were hospitalized in the Asheville Orthopedic Hospital and the Mercy Hospital in Charlotte. A few patients were admitted to the Central Carolina Convalescent Hospital in Greensboro, the North Carolina Memorial Hospital in Chapel Hill, the North Carolina Baptist Hospital in Winston-Salem, and the Duke University Hospital in Durham. Only a few cases were admitted to the local Caldwell County Memorial Hospital due to a lack of extensive facilities. After receipt of the report, a county health nurse visited the patient's home to collect data on the family and on living conditions.

## Definition of a Case

Only cases with onsets between April 1, 1953, and August 22, 1953, are included in this report, provided there was paralysis or at least 10 cells in the spinal fluid. A case was considered "suspect" if no paralysis was noted, and if no spinal puncture had been performed, or less than 10 cells were found in the spinal fluid. "Suspect" cases are not included in the analysis.

A total of 139 cases was reported between April 1 and August 22, of which 134 are included in this analysis. The 5 cases not included are 3 cases classified as "suspect," 1 case a nonresident of the county, and 1 patient definitely not ill with poliomyelitis.

Five cases with dates of onset between August 23 and October 31 were reported, but they are not included in this analysis because no accurate data were available for them.

## Area and Poliomyelitis History

The population of the county according to the 1950 census was 43,352, representing a 21 percent increase over the 1940 population. Lenoir is the only city of any size with 7,888 inhabitants. The county has a 54 percent rural-nonfarm population. Only 6.9 percent of the population are nonwhite.

Caldwell County is adjacent to Catawba County and is located in the west central part of North Carolina. The county is agricultural and the industries center on the manufacture of furniture and hosiery. The economic fluctuations common to these industries account for the large rural-nonfarm population. The makeup of the population is considered very stable.

**Table 1. Number of reported cases of poliomyelitis (paralytic and nonparalytic), Caldwell County, N. C., 1940–52**

| *Year* | *Reported cases* |
|---|---|
| 1940 | 1 |
| 1941 | 3 |
| 1942 | 12 |
| 1943 | 2 |
| 1944 | 43 |
| 1945 | 3 |
| 1946 | 2 |
| 1947 | 1 |
| 1948 | 32 |
| 1949 | 4 |
| 1950 | 21 |
| 1951 | 16 |
| 1952 | 13 |

SOURCE: Caldwell County Health Department.

Poliomyelitis is endemic in the area with sizable epidemics being reported in 1944 and 1948. Cases of poliomyelitis have occurred every year since 1938 (table 1).

## Administration of Gamma Globulin

Gamma globulin was available to household contacts under age 20 and to pregnant women in the household, regardless of age. The injections were given by the private physician or the contacts were brought to the county health department and given injections by the health officer. Inoculations were usually given on the same day or on the day following the date of report of the index case. A gamma globulin request form, signed by the physician, listed all who were to receive injections, their ages and weights, and the total amount of gamma globulin required for the household.

Mass prophylaxis was undertaken on July 6, 7, and 8, following the rising incidence of reported cases. Certification for mass prophylaxis had been obtained on July 2, 1953. Gamma globulin was administered to 12,802 children, age 10 and under, and also to older children on the last day of the mass inoculation program.

## Epidemiologic Investigation

Since all reported cases in Caldwell County had been hospitalized and most had had spinal taps, initial work was undertaken by the Epidemic Intelligence Service team in the various

**Table 2. Distribution of total and paralytic cases of poliomyelitis by week of report and week of onset,[1] Caldwell County, N. C., 1953**

| Week | Week of report | | Week of onset | | | |
|---|---|---|---|---|---|---|
| | Total cases | Number paralytic cases | Total cases | Number paralytic cases | Age 0–9 | |
| | | | | | Total cases | Paralytic cases |
| Apr. 12–18 | 1 | 1 | 2 | 2 | 1 | 1 |
| Apr. 19–25 | 2 | 1 | 2 | 1 | 1 | 1 |
| Apr. 26–May 2 | 0 | 0 | 1 | 1 | 0 | 0 |
| May 3–9 | 3 | 3 | 1 | 1 | 0 | 0 |
| May 10–16 | 1 | 1 | 1 | 1 | 1 | 1 |
| May 17–23 | 1 | 1 | 2 | 2 | 2 | 2 |
| May 24–30 | 6 | 3 | 6 | 3 | 6 | 3 |
| May 31–June 6 | 4 | 4 | 4 | 4 | 3 | 3 |
| June 7–13 | 3 | 3 | 5 | 4 | 4 | 3 |
| June 14–20 | 7 | 6 | 15 | 12 | 15 | 12 |
| June 21–27 | 16 | 13 | 23 | 15 | 21 | 13 |
| June 28–July 4 | 27 | 18 | 26 | 18 | 22 | 14 |
| July 5–11 | 20 | 13 | 22 | 15 | 15 | 10 |
| July 6–8.[2] | | | | | | |
| July 12–18 | 22 | 15 | 13 | 10 | 8 | 7 |
| July 19–25 | 7 | 6 | 6 | 4 | 3 | 2 |
| July 26–Aug. 1 | 4 | 4 | 4 | 3 | 3 | 3 |
| Aug. 2–8 | 9 | 3 | 1 | 0 | 0 | 0 |
| Aug. 9–15 | 1 | 1 | 0 | 0 | 0 | 0 |
| Total | 134 | 96 | 134 | 96 | 105 | 75 |

[1] Suspect cases not included.
[2] Mass prophylaxis.

hospitals in Asheville, Durham, Chapel Hill, Charlotte, Winston-Salem, and Greensboro, as well as in the local hospitals. From August 3 to August 14, a visit was made to the household of every reported case and information for the completion of case investigation form 400.88A (appendix D) was obtained by a personal interview with the parents of the patient or other adult household members. In addition, information concerning sanitary conditions in each household was collected on a form supplied by the North Carolina State Board of Health.

Whenever circumstances would permit, a

**Table 3A. Distribution of paralytic and total cases of poliomyelitis, by age, sex, and race, Caldwell County N. C., 1953**

| Age | Paralytic cases | | | | | | | Total cases | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | White | | | Nonwhite | | | Total | White | | | Nonwhite | | | Total |
| | Male | Female | Total | Male | Female | Total | | Male | Female | Total | Male | Female | Total | |
| <1 year | 2 | 3 | 5 | 0 | 1 | 1 | 6 | 4 | 5 | 9 | 2 | 1 | 3 | 12 |
| 1–4 years | 22 | 26 | 48 | 2 | 1 | 3 | 51 | 29 | 35 | 64 | 3 | 1 | 4 | 68 |
| 5–9 years | 5 | 12 | 17 | 1 | 0 | 1 | 18 | 8 | 16 | 24 | 1 | 0 | 1 | 25 |
| 10–14 years | 3 | 7 | 10 | 1 | 1 | 2 | 12 | 5 | 9 | 14 | 1 | 1 | 2 | 16 |
| 15 years and over | 6 | 3 | 9 | 0 | 0 | 0 | 9 | 7 | 6 | 13 | 0 | 0 | 0 | 13 |
| All ages | 38 | 51 | 89 | 4 | 3 | 7 | 96 | 53 | 71 | 124 | 7 | 3 | 10 | 134 |

**Table 3B. 1950 populations, Caldwell County, N. C.**

| Age | White | | | Nonwhite | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| <1 year | 519 | 511 | 1, 030 | 58 | 39 | 97 | 577 | 550 | 1, 127 |
| 1–4 years | 2, 167 | 2, 027 | 4, 194 | 166 | 165 | 331 | 2, 333 | 2, 192 | 4, 525 |
| 5–9 years | 2, 436 | 2, 325 | 4, 761 | 189 | 172 | 361 | 2, 625 | 2, 497 | 5, 122 |
| 10–14 years | 2, 122 | 2, 129 | 4, 251 | 147 | 163 | 310 | 2, 269 | 2, 292 | 4, 561 |
| 15 years and over | 12, 853 | 13, 265 | 26, 118 | 908 | 991 | 1, 899 | 13, 761 | 14, 256 | 28, 017 |
| All ages | 20, 097 | 20, 257 | 40, 354 | 1, 468 | 1, 530 | 2, 998 | 21, 565 | 21, 787 | 43, 352 |

**Table 3C. Attack rates per 100,000 population for paralytic and total cases by sex, race and age, Caldwell County, N. C.**

| Age | Paralytic cases | | | | | | | Total cases | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | White | | | Nonwhite | | | Total | White | | | Nonwhite | | | Total |
| | Male | Female | Total | Male | Female | Total | | Male | Female | Total | Male | Female | Total | |
| <1 year | 385 | 587 | 485 | 0 | 2, 564 | 1, 031 | 532 | 771 | 978 | 874 | 3, 448 | 2, 564 | 3, 093 | 1, 065 |
| 1–4 years | 1, 015 | 1, 283 | 1, 144 | 1, 205 | 606 | 906 | 1, 127 | 1, 338 | 1, 727 | 1, 526 | 1, 807 | 606 | 1, 208 | 1, 503 |
| 5–9 years | 205 | 516 | 357 | 529 | 0 | 277 | 351 | 328 | 688 | 504 | 529 | 0 | 277 | 488 |
| 10–14 years | 141 | 329 | 235 | 680 | 613 | 645 | 263 | 236 | 423 | 329 | 680 | 613 | 645 | 351 |
| 15 years and over | 47 | 23 | 34 | 0 | 0 | 0 | 32 | 54 | 45 | 50 | 0 | 0 | 0 | 46 |
| All ages | 189 | 252 | 221 | 272 | 196 | 233 | 221 | 264 | 350 | 307 | 477 | 196 | 334 | 309 |

muscle evaluation was performed by the EIS officers, as a means of verifying the diagnosis of paralysis.

*Past Epidemics of Poliomyelitis*

While the magnitudes of the past epidemics do not approach the 1953 outbreak, it seems of interest to examine the shapes of the epidemic curves for these past epidemics. An outstanding characteristic of the epidemic curves for 1948, 1950, 1951, and 1952 is the prominent skewness to the left, which means that the epidemics built more slowly to a peak than they declined. The present epidemic is fairly symmetrical.

*Distribution of Cases in Time*

The first case in this epidemic had its onset on April 16, and the last case occurred on August 5. The distribution of cases by dates of onset (table 2) presents a progressive rise beginning in mid-May and continuing until a peak was reached during the week ending July 4. Then there was a gradual decline somewhat different from previous epidemics. Mass prophylaxis was given on July 6, 7, and 8, the week

**Table 4A. Distribution of total and paralytic cases of poliomyelitis, by race, sex, and area of residence, Caldwell County, N. C., 1953**

| Place of residence | Paralytic cases | | | | | | Total | Total cases | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | White | | | Nonwhite | | | | White | | | Nonwhite | | | |
| | Male | Female | Total | Male | Female | Total | | Male | Female | Total | Male | Female | Total | |
| Lenoir | 6 | 3 | 9 | 2 | 1 | 3 | 12 | 8 | 7 | 15 | 4 | 1 | 5 | 20 |
| Rural | 32 | 48 | 80 | 2 | 2 | 4 | 84 | 45 | 64 | 109 | 3 | 2 | 5 | 114 |
| Total | 38 | 51 | 89 | 4 | 3 | 7 | 96 | 53 | 71 | 124 | 7 | 3 | 10 | 134 |

**Table 4B. 1950 populations, Caldwell County, N. C.**

| Place of residence | White | | | Nonwhite | | | Total |
|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total | |
| Lenoir | 3, 081 | 3, 260 | 6, 341 | 758 | 789 | 1, 547 | 7, 888 |
| Rural | 17, 016 | 16, 997 | 34, 013 | 710 | 741 | 1, 451 | 35, 464 |
| Total | 20, 097 | 20, 257 | 40, 354 | 1, 468 | 1, 530 | 2, 998 | 43, 352 |

**Table 4C. Attack rates per 100,000 population for total and paralytic cases by sex, race and area of residence, Caldwell County, N. C.**

| Place of residence | Paralytic cases | | | | | | | Total cases | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | White | | | Nonwhite | | | Total | White | | | Nonwhite | | | Total |
| | Male | Female | Total | Male | Female | Total | | Male | Female | Total | Male | Female | Total | |
| Lenoir | 195 | 92 | 142 | 264 | 127 | 194 | 152 | 260 | 215 | 237 | 528 | 127 | 323 | 254 |
| Rural | 188 | 282 | 235 | 282 | 270 | 276 | 237 | 264 | 377 | 320 | 423 | 270 | 345 | 321 |
| Total | 189 | 252 | 221 | 272 | 196 | 233 | 221 | 264 | 350 | 307 | 477 | 196 | 334 | 309 |

Figure 1A. Total weekly poliomyelitis incidence rates per 100,000 population, Caldwell County, N. C., 1953, by week of report, and paralytic status of cases, by week of onset.

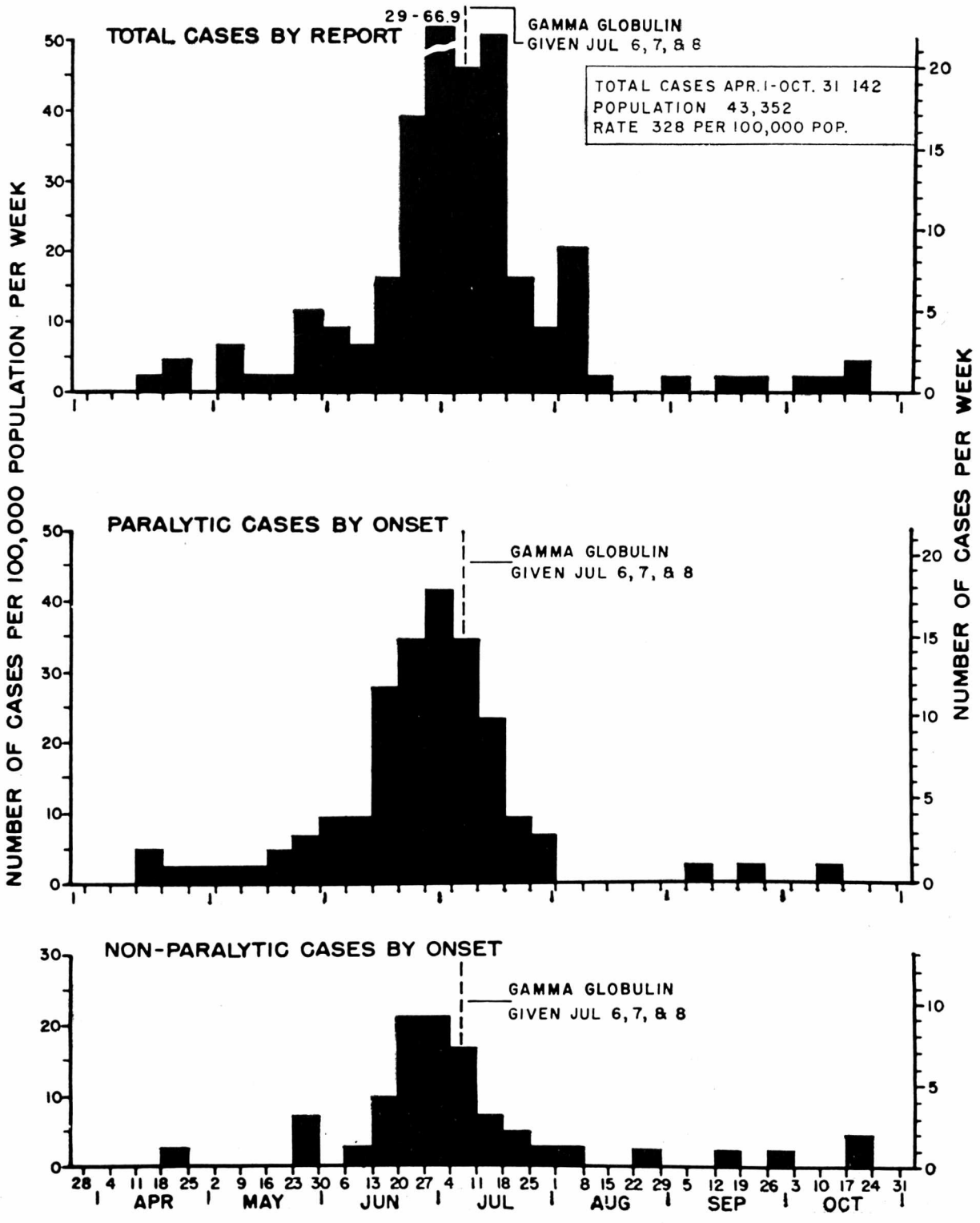

Figure 1B. Number of cases of poliomyelitis, Caldwell County, N. C., 1953, by week of onset, age group, and paralytic status.

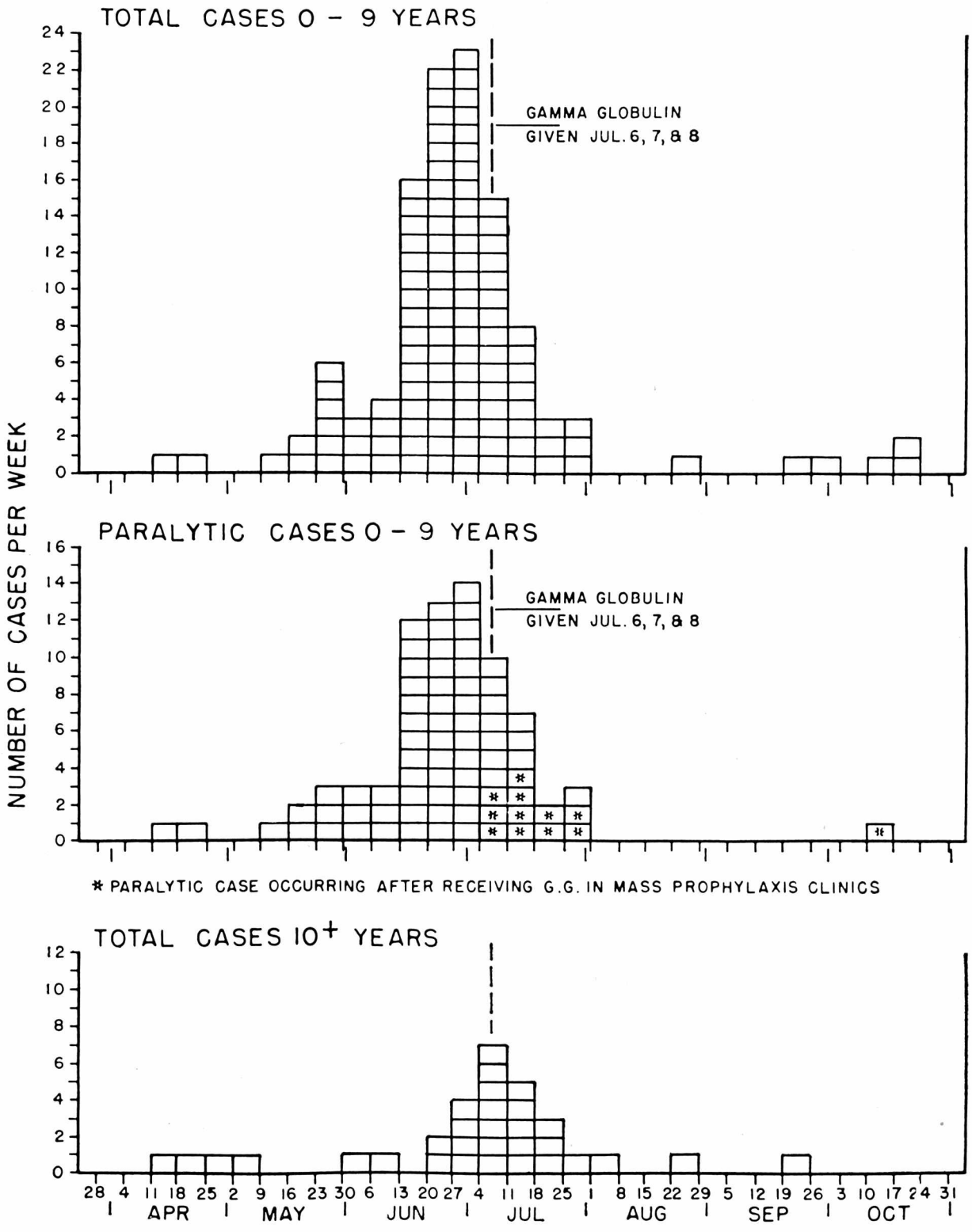

**Table 5. Interval in days between onset of index and subsequent cases in multiple-case households, Caldwell County, N. C., 1953**

| Interval (days) | Total cases | Paralytic cases |
|---|---|---|
| 0 | 3 | 2 |
| 1 | 1 | 1 |
| 2 | 1 | 1 |
| 3 | 1 | 1 |
| 4 | 1 | 1 |
| 5 | 1 | 0 |
| 6 | 0 | 0 |
| 7 | 0 | 0 |
| 8 | 1 | 1 |
| 9 | 2 | 1 |
| 10–37 | 0 | 0 |
| 38 | 0 | 0 |
| Total | 11 | 8 |

after the peak of the outbreak has been reached.

The temporal patterns of the paralytic and the nonparalytic cases are similar, the curves peaking simultaneously, although the curve of the nonparalytic cases is skewed slightly to the right. The distribution of cases under age 10, and age 10 and over, is somewhat different. The 105 cases under age 10 peaked the week ending July 4, and the curve declined more rapidly than the curve of cases age 10 and over which reached its peak one week later.

There was little lag between the date of onset and the date of report as revealed by the distribution of cases by week of report (table 2).

### *General Characteristics of Cases*

The data on age, sex, race, area of residence, and status of paralysis of the cases are presented in tables 3A and 4A. Attack rates are presented in tables 3C and 4C. Population characteristics according to the 1950 census are presented in tables 3B and 4B. Among the total cases, there were 6 deaths, a case fatality rate of 4.5 percent.

The total attack rate for the county is 309 per 100,000 population. The attack rate per 100,000 population is 307 for whites and 334 for nonwhites. The total attack rate for white males is 264 per 100,000 population as compared with an attack rate of 350 per 100,000 population for white females. Attack rates for cases in Lenoir are 254 as compared with 321 for rural cases. The differences are not significant. Of the total cases, 60, or 45 percent, were male. Severity did not increase with increasing age. Seventy-one percent of all cases under age 10 were diagnosed as paralytic in the 7–14 day examination, and 72 percent of all cases age 10 and over were diagnosed as nonparalytic.

### *Special Characteristics of Cases*

Of the total cases, 17, or 13 percent, had histories of throat and mouth operations, injections, or other procedures. These patients represent 14 percent of all paralytic cases and 11 percent of nonparalytic cases.

None of the female patients were pregnant at the time of their illness.

Bulbar involvement was found in 16 cases, or 12 percent of all cases. Of these 16 cases, 9 represent 9 percent of the cases under age 10 and 7 represent 24 percent of the cases age 10 or over. The difference between these two proportions is statistically significant.

### *Familial Aggregation*

The 7 multiple-case households considered in this analysis totaled 18 cases, and consist of 1

**Table 6. Age-specific subsequent attack rates, Caldwell County, N. C., 1953**

| Age group | Number of household contacts of index cases | Number of subsequent cases | | Subsequent attack rate per 100,000 population | |
|---|---|---|---|---|---|
| | | Total | Paralytic | Total | Paralytic |
| <5 years | 103 | 5 | 3 | 4, 854 | 2, 913 |
| 5–9 years | 90 | 2 | 2 | 2, 222 | 2, 222 |
| 10 years and over | 385 | 4 | 3 | 1, 039 | 779 |
| All ages | 578 | 11 | 8 | 1, 903 | 1, 384 |

**Table 7. Summary of index and subsequent cases of poliomyelitis in multiple-case households, Caldwell County, N. C., 1953** [1]

| Household accession No. | Person No. | Date of onset | Age | Sex | Paralytic status 7–14 day examination | Percent involvement 50–70 day physical therapist examination | Interval from index case (days) | Interval gamma globulin to onset (days) |
|---|---|---|---|---|---|---|---|---|
| | A. Index cases (none received gamma globulin) | | | | | | | |
| 0001 | 6 | May 31 | 7 | F | P | 11.1 | ---------- | |
| 0002 | 3 | June 14 | 10 mo. | F | P | 18.9 | ---------- | |
| 0003 | 4 | June 19 | 1 | F | NP | 0.0 | ---------- | |
| 0004 | 3 | June 27 | 3 | F | P | 82.5 | ---------- | |
| 0005 | 3 | June 25 | 5 | F | NP | 4.9 | ---------- | |
| 0006 | 4 | July 4 | 19 | F | P | 93.2 | ---------- | |
| 0007 | 4 | July 21 | 17 | F | P | 83.8 | ---------- | |
| | B. Subsequent cases (receiving gamma globulin) | | | | | | | |
| 0001 | 8 | June 9 | 12 | F | P | 56.0 | 9 | 6 |
| 0005 | 6 | July 4 | 6 mo. | F | NP | 3.0 | 9 | 8 |
| 0007 | 6 | July 29 | 1 mo. | F | P | (2) | 8 | 6 |
| | C. Subsequent cases (not receiving gamma globulin) | | | | | | | |
| 0001 | 5 | May 31 | 5 | F | P | 74.7 | 0 | |
| 0001 | 7 | June 2 | 10 | F | P | 92.0 | 2 | |
| 0002 | 3 | June 17 | 4 | M | P | 5.5 | 3 | |
| 0003 | 3 | June 23 | 9 mo. | F | P | 34.7 | 4 | |
| 0003 | 2 | July 27 | 21 | F | NP | 3.4 | 38 | |
| 0004 | 4 | June 28 | 5 | F | P | 4.3 | 1 | |
| 0005 | 5 | June 25 | 2 | M | NP | 5.5 | 0 | |
| 0006 | 3 | July 4 | 21 | F | P | (3) | 0 | |

P=paralytic; NP=nonparalytic.

[1] Suspect cases not included.
[2] Expired 3 days after onset.
[3] Expired 9 days after onset.

household with 4 cases, 2 with 3 cases, and 4 with 2 cases. A summary of subsequent cases in these multiple-case households by days after onset of the index case is shown in table 5.

There were 11 subsequent cases among the 578 contacts of index cases giving a total subsequent attack rate of 1,903 per 100,000 contacts (table 6). For children under age 5, the subsequent attack rate is 4,854 per 100,000 contacts of an index case. This rate is significantly higher than the attack rate of 1,415 per 100,000 population found in children of the same age group in the county.

Three of the subsequent cases had received gamma globulin 6 or more days prior to onset; one case was nonparalytic, one case was severely paralytic, and one died. A summary of all cases in multiple-case households is presented in table 7.

### *Effects of Gamma Globulin*

To evaluate the effect of gamma globulin in modifying the severity of disease, standardized 50–70 day muscle examinations were conducted by a physical therapist on three groups of cases:

1. Cases whose onsets fell within the week June 29 through July 5, who did not receive gamma globulin (table 8A).

2. Cases whose onsets fell on July 6 or after, who did not receive gamma globulin (table 8B).

**Table 8. Summary of cases of poliomyelitis age 9 and under who received 50–70 day muscle examinations Caldwell County, N. C.**

| Household accession number | Person number | Date of onset | Age | Sex | 7–14 day examination | 50–70 day muscle examination | | Interval gamma globulin to onset (days) |
|---|---|---|---|---|---|---|---|---|
| | | | | | Paralytic status | Percent involvement | Bulbar involvement | |
| | A. All cases with onset in the week of June 29–July 5, which did not receive gamma globulin [1] | | | | | | | |
| 1006 | 8 | June 30 | 11 mo. | M | NP | 0. 0 | No. | |
| 1017 | 4 | June 29 | 6 | F | NP | 3. 0 | Yes | |
| 1019 | 4 | July 3 | 1 | F | P | 0. 0 | No | |
| 1041 | 5 | July 4 | 6 | F | P | 34. 8 | Yes | |
| 1051 | 4 | June 30 | 4 | M | P | 13. 5 | Yes | |
| 1067 | 6 | June 29 | 7 | M | P | 15. 1 | No | |
| 1068 | 4 | June 30 | 4 | M | P | 27. 3 | Yes | |
| 1075 | 3 | June 29 | 1 | M | P | 3. 8 | No | |
| 1078 | 3 | June 29 | 1 | M | P | 2. 8 | No | |
| 1091 | 3 | July 5 | 4 | M | P | 2. 8 | No | |
| 1094 | 8 | July 2 | 3 | F | NP | 4. 5 | No | |
| 1095 | 5 | June 30 | 1 | M | P | 0. 0 | No | |
| 1100 | 6 | July 1 | 3 | F | NP | 0. 6 | No | |
| 1103 | 6 | June 30 | 1 | F | P | 13. 6 | No | |
| 1105 | 4 | July 1 | 2 | F | P | 75. 5 | Yes | |
| 1109 | 7 | June 29 | 3 | M | P | 23. 5 | Yes | |
| 1111 | 5 | July 3 | 2 mo. | M | NP | 0. 0 | No | |
| | B. All cases with onset in the week of July 6 or thereafter, which did not receive gamma globulin [1] | | | | | | | |
| 1001 | 4 | July 17 | 9 | F | P | 11. 9 | No | |
| 1007 | 5 | July 7 | 1 | F | P | 70. 7 | Yes | |
| 1018 | 5 | July 17 | 4 | M | P | 3. 6 | No | |
| 1030 | 8 | July 7 | 9 | M | P | 8. 6 | No | |
| 1027 | 4 | July 6 | 1 | F | P | 40. 9 | Yes | |
| 1039 | 4 | July 7 | 2 | F | NP | 0. 0 | No | |
| 1050 | 3 | July 8 | 3 | F | P | 55. 5 | Yes | |
| 1063 | 8 | July 16 | 1 | F | P | 7. 1 | Yes | |
| 1089 | 7 | July 13 | 2 mo. | M | P | 3. 8 | No | |
| 1099 | 4 | July 7 | 4 | F | P | 4. 6 | Yes | |
| 1108 | 9 | Aug. 1 | 8 mo. | M | P | 0. 4 | Yes | |
| | C. All cases with onset in the week of July 6 or thereafter, which did receive gamma globulin [1] | | | | | | | |
| 1004 | 4 | July 7 | 1 | M | P | 12. 8 | Yes | 1 |
| 1009 | 4 | July 9 | 6 | M | NP | 0. 0 | No | 2 |
| 1016 | 6 | July 11 | 1 | F | NP | 0. 0 | No | 3 |
| 1023 | 4 | July 12 | 1 | M | P | 31. 9 | Yes | 5 |
| 1034 | 3 | July 13 | 8 | M | P | 0. 0 | No | 7 |
| 1046 | 4 | July 13 | 2 mo. | F | NP | 1. 6 | Yes | 7 |
| 1056 | 11 | July 10 | 10 mo. | M | NP | 0. 0 | No | 4 |
| 1058 | 5 | July 7 | 4 | M | P | 6. 6 | No | 1 |
| 1072 | 9 | July 11 | 4 | F | P | 1. 5 | No | 5 |
| 1081 | 6 | July 24 | 6 | F | P | 1. 3 | No | 17 |
| 1083 | 7 | July 8 | 7 | M | P | 8. 7 | No | 2 |
| 1085 | 5 | July 13 | 2 | M | P | 1. 1 | No | 7 |
| 1090 | 6 | July 27 | 1 | F | P | 20. 6 | No | 20 |
| 1092 | 3 | July 23 | 6 | F | P | 4. 0 | No | 17 |
| 1110 | 3 | July 8 | 4 | M | NP | 0. 0 | No | 2 |

P=paralytic. NP=nonparalytic.

[1] Cases receiving gamma globulin on day of onset, or after onset not included. Cases in multiple-case households not included.

**Table 9. Distribution of average percent involvement for three groups of cases having 50–70 day muscle examinations,[1] Caldwell County, N. C., 1953**

| 7–14 day examination paralytic status | Onsets June 29–July 5 (no gamma globulin) | | Onsets July 6 and thereafter (no gamma globulin) | | Onsets July 6 and thereafter (gamma globulin) | |
|---|---|---|---|---|---|---|
| | Number cases | Average involvement (percent) | Number cases | Average involvement (percent) | Number cases | Average involvement (percent) |
| Paralytic | 12 | 17. 7 | 10 | 20. 7 | 11 | 9. 0 |
| Nonparalytic | 5 | 1. 6 | 1 | 0. 0 | 4 | 0. 0 |
| All cases | 17 | 13. 0 | 11 | 18. 8 | 15 | 6. 0 |

[1] This table is prepared from data in table 8.

3. Cases whose onsets fell on July 6 or after, who had received gamma globulin (table 8C).

Only cases under age 10 were included and data on all but one eligible case were successfully collected. Not included in this analysis are the cases in multiple-case households.

Among the 44 cases included in the three groups, 16, or 36 percent, were found to have bulbar involvement, though the 7–14 day examination revealed only 4, or 9 percent, as having bulbar involvement. To evaluate the measurable modifying effects of gamma globulin, a crude statistic, the average percent involvement, is employed. This is the arithmetic average of the percent involvement for the cases in the various classifications. Its crudeness is a reflection of the great variation of percent involvement from case to case.

A summary of the average percent involvement for the three groups is presented in table 9. It is interesting to note that cases diagnosed as nonparalytic in the 7–14 day examination had an average percent involvement of 1.3 percent, whereas the cases diagnosed as paralytic had an average percent involvement of 19.1 percent. The cases were classified according to paralytic status as determined in the 7–14 day examination.

Among the 12 and 10 paralytic cases in groups 1 and 2, respectively, the average percent involvements were 17.7 percent and 20.7 percent as compared to 9.0 percent for the 11 paralytic cases in group 3 (the group receiving gamma globulin). The differences are not statistically significant.

Among the 17 and 11 total cases in groups 1 and 2, the average percent involvements were 13.0 percent and 18.8 percent as compared with 6.0 percent for the 15 cases in group 3.

While the results are consistent with the hypothesis that gamma globulin modifies the severity of paralysis, they are neither conclusive nor dramatic. A look at the range of severity among cases receiving gamma globulin prior to onset bears this out; involvements range from 0.0 percent to 31.9 percent.

## Summary

A description of an epidemic of 134 cases of poliomyelitis occurring in Caldwell County, N. C., between April 16 and August 5, 1953, is presented. The total attack rate for the county was 309 per 100,000 population, and the peak of the rather symmetric epidemic curve occurred during the week ending July 4. On July 5, 6, and 7, gamma globulin was administered to 12,802 children in the mass prophylaxis program. There is little evidence to conclude that mass prophylaxis with gamma globulin altered the course of the epidemic.

Muscle evaluation data were analyzed to investigate the effects of gamma globulin on the paralytic disease. No statistically valid conclusions could be drawn from the results.

# Catawba County, North Carolina

On July 29, 1953, Dr. Fred T. Foard, director, division of epidemiology, North Carolina State Board of Health, requested the services of a team from the Communicable Disease Center to aid in an epidemiologic investigation of an outbreak of poliomyelitis in Caldwell, Catawba, and Avery Counties. This report deals with the outbreak in Catawba County. At the time of the request, a total of 91 cases had been reported in Catawba County since January 1, 1953. Of these, 35, or 38 percent, had been reported as paralytic; 48, or 53 percent, had been reported as nonparalytic; and 8, or 9 percent, were unspecified. Up to July 29, there had been 4 deaths, a case-fatality rate of 4 percent. The total attack rate at this time was 147 per 100,000 population based on the 1950 census figures. Of the reported cases, 84 percent had been hospitalized.

A team under the direction of Dr. J. Graham Smith, Epidemic Intelligence Service officer, assigned to the North Carolina State Board of Health, and composed of Dr. Martin D. Keller, EIS, Dr. Heinz Eichenwald, EIS, and Harold W. Black, statistician, reported to Dr. Benton V. D. Scott, health officer of Catawba County, on August 15, 1953. The survey work was completed on August 20, 1953.

## Methods of Reporting

The final diagnosis was often based on a report from the hospital, and in the absence of such a report, no further measures were taken by the county health department to confirm the attending physician's diagnosis. The cases were located in hospitals in Asheville, Charlotte, Winston-Salem, Greensboro, and Hickory. Following the report of a case, county health nurses visited the patients' homes to collect data on the families and on their living conditions.

## Definition of a Case

Only cases with onsets between April 1, 1953, and August 22, 1953, are included in this report, provided there was paralysis or at least 10 cells in the spinal fluid. A case was considered "suspect" if no paralysis was noted, and if no spinal puncture had been performed, or less than 10 cells were found in the spinal fluid.

A total of 95 cases was reported between April 1 and August 22, of which 86 are included in the analysis. The 9 cases excluded were classified as "suspect" cases. In addition, there were 5 patients with onsets between August 23 and October 31 that are not included in this analysis due to a lack of accurate data.

## Area and Poliomyelitis History

The population of Catawba County according to the 1950 census was 61,794, representing a 19.6 percent increase over the 1940 population. Hickory, an industrial center, is the largest city in the county, with a population of 14,755. The only other sizable urban center is Newton, with a population of 6,039. The population of the county is 34 percent urban and 10 percent nonwhite.

Catawba County is adjacent to Caldwell County and is located in the west central part of North Carolina. The county is both agricultural and industrial in character, with the industries including furniture and textile manufacturing. The structure of the population is considered very stable.

Poliomyelitis is endemic in the area, with sizable epidemics of 71 cases and 97 cases being reported in 1944 and 1948, respectively; and cases have been reported every year since 1940 (table 1).

## Administration of Gamma Globulin

Gamma globulin was available to household contacts under age 20 and to pregnant women of the household, regardless of age. The injections were administered by the private physician or the contacts were brought to the county health department and received injections by the health officer. Inoculations were usually given on the same day, or on the day following the date of report of the index case. A gamma globulin request form, signed by the physician,

**Table 1. Number of reported cases of poliomyelitis (paralytic and nonparalytic), Catawba County, N. C., 1940–52**

| *Year* | *Cases* |
|---|---|
| 1940 | 0 |
| 1941 | 4 |
| 1942 | 4 |
| 1943 | 1 |
| 1944 | 71 |
| 1945 | 1 |
| 1946 | 14 |
| 1947 | 6 |
| 1948 | 97 |
| 1949 | 13 |
| 1950 | 6 |
| 1951 | 18 |
| 1952 | 8 |

listed all who were to receive injections, their ages and weights, and the total amount of gamma globulin required for the household.

Mass prophylaxis was undertaken on July 15 and 16, following the rising incidence of reported cases and certification of eligibility on July 10. Gamma globulin was administered to 14,786 children from birth to age 10, and also to older children on the last day of the mass inoculation program.

## Epidemiologic Investigation

Since most of the patients were hospitalized and many had had spinal taps, initial work was undertaken in the various hospitals in Charlotte, Winston-Salem, Greensboro, and Hickory to collect diagnostic and clinical information. In addition, physicians and local laboratories were consulted in order to obtain additional clinical and diagnostic information. From August 15 to August 19, a visit was made to the household of every reported case, and information for the completion of case investigation form 400.88A (appendix D) was obtained by a personal interview of the parents of the patients or other adult members. Whenever circumstances permitted, a muscle evaluation of the case was performed by the EIS officers as a means of verifying the diagnosis of paralysis.

### *Past Epidemics of Poliomyelitis*

The noteworthy characteristic of the epidemics of 71 cases in 1944 and of 97 cases in 1948 is that both epidemic curves are fairly symmetric. In the 1948 epidemic, the distribution of cases under age 10 and the distribution of cases age 10 and over reach a peak in the same week and present the same general appearance. However, the distribution of cases under age 10 spans a 5-month interval, while the distribution of cases age 10 and over spans a 3-month interval.

### *Distribution of Cases in Time*

The first reported case included in this study had its onset June 7, and the last case had its

**Table 2. Distribution of total and paralytic cases of poliomyelitis, by week of report and week of onset,[1] Catawba County, N. C., 1953**

| Week | Week of report | | Week of onset | | | |
|---|---|---|---|---|---|---|
| | | | | | Ages 0–9 | |
| | Total cases | Paralytic cases | Total cases | Paralytic cases | Total cases | Paralytic cases |
| June 7–13 | 1 | 1 | 1 | 1 | 1 | 1 |
| June 14–20 | 2 | 2 | 7 | 6 | 7 | 6 |
| June 21–27 | 3 | 2 | 4 | 4 | 3 | 3 |
| June 28–July 4 | 11 | 11 | 14 | 13 | 10 | 10 |
| July 5–11 | 22 | 18 | 26 | 21 | 19 | 16 |
| July 12–18 | 20 | 17 | 15 | 12 | 11 | 8 |
| July 15–16 [2] | | | | | | |
| July 19–25 | 17 | 13 | 15 | 10 | 6 | 5 |
| July 26–Aug. 1 | 9 | 6 | 4 | 3 | 0 | 0 |
| Aug. 2–8 | 0 | 0 | 0 | 0 | 0 | 0 |
| Aug. 9–15 | 1 | 0 | 0 | 0 | 0 | 0 |
| Total | 86 | 70 | 86 | 70 | 57 | 49 |

[1] Suspect cases not included.
[2] Mass prophylaxis.

onset July 31. This epidemic is somewhat unusual in that all 86 cases had onsets within a narrow 8-week interval. From the week the first case occurred, there was a rapid rise in the number of cases per week until a peak was reached during the fifth week, and then a rapid decline followed until the fourth week after the peak, when no more cases occurred.

The peak of the distribution of onsets of paralytic cases occurred in the fifth week, while peaks of the distribution of nonparalytic cases occurred in the fifth week and in the seventh

**Table 3A. Distribution of paralytic and total cases of poliomyelitis by age, sex and race, Catawba County, N. C., 1953**

| Age | Paralytic cases | | | | | | | Bulbar cases | Total cases | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | White | | | Nonwhite | | | Total | | White | | | Nonwhite | | | Total |
| | Male | Female | Total | Male | Female | Total | | | Male | Female | Total | Male | Female | Total | |
| <1 year | 2 | 1 | 3 | 0 | 0 | 0 | 3 | | 2 | 1 | 3 | 0 | 0 | 0 | 3 |
| 1–4 years | 19 | 15 | 34 | 0 | 1 | 1 | 35 | 5 | 20 | 16 | 36 | 0 | 1 | 1 | 37 |
| 5–9 years | 10 | 1 | 11 | 0 | 0 | 0 | 11 | 1 | 14 | 3 | 17 | 0 | 0 | 0 | 17 |
| 10–14 years | 4 | 3 | 7 | 0 | 0 | 0 | 7 | 2 | 4 | 6 | 10 | 0 | 0 | 0 | 10 |
| 15+ years | 9 | 5 | 14 | 0 | 0 | 0 | 14 | 5 | 10 | 9 | 19 | 0 | 0 | 0 | 19 |
| All ages | 44 | 25 | 69 | 0 | 1 | 1 | 70 | 13 | 50 | 35 | 85 | 0 | 1 | 1 | 86 |

**Table 3B. 1950 populations, Catawba County, N. C.**

| Age | White | | | Nonwhite | | | Total |
|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total | |
| <1 year | 609 | 634 | 1,243 | 69 | 75 | 144 | 1,387 |
| 1–4 years | 2,868 | 2,786 | 5,654 | 340 | 315 | 655 | 6,309 |
| 5–9 years | 2,971 | 2,758 | 5,729 | 348 | 335 | 683 | 6,412 |
| 10–14 years | 2,569 | 2,433 | 5,002 | 301 | 267 | 568 | 5,570 |
| 15+ years | 18,757 | 19,811 | 38,568 | 1,683 | 1,865 | 3,548 | 42,116 |
| All ages | 27,774 | 28,422 | 56,196 | 2,741 | 2,857 | 5,598 | 61,794 |

**Table 3C. Attack rates per 100,000 population, Catawba County, N. C., 1953**

| Age | Paralytic cases | | | | | | | Total cases | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | White | | | Nonwhite | | | Total | White | | | Nonwhite | | | Total |
| | Male | Female | Total | Male | Female | Total | | Male | Female | Total | Male | Female | Total | |
| <1 year | 328 | 158 | 241 | 0 | 0 | 0 | 216 | 328 | 158 | 241 | 0 | 0 | 0 | 216 |
| 1–4 years | 662 | 538 | 601 | 0 | 317 | 153 | 555 | 697 | 574 | 637 | 0 | 317 | 153 | 586 |
| 5–9 years | 337 | 36 | 192 | 0 | 0 | 0 | 172 | 471 | 109 | 297 | 0 | 0 | 0 | 265 |
| 10–14 years | 156 | 123 | 140 | 0 | 0 | 0 | 126 | 156 | 247 | 200 | 0 | 0 | 0 | 180 |
| 15 years and over | 48 | 25 | 36 | 0 | 0 | 0 | 33 | 53 | 45 | 49 | 0 | 0 | 0 | 45 |
| All ages | 158 | 88 | 123 | 0 | 35 | 18 | 113 | 180 | 123 | 151 | 0 | 35 | 18 | 139 |

week of the 8-week epidemic. Mass prophylaxis was conducted on July 15 and 16, during the sixth week of the epidemic (the week following the peak of the epidemic). The distribution of cases under age 10 and cases age 10 and over reached their peak 2 weeks apart; the former peaked during the fifth week, and the latter peaked during the seventh week of the epidemic. This indicates the quite apparent shift to cases in older age groups as the epidemic progressed.

As the distribution of cases by date of report (table 2) indicates, there was little lag between the date of onset and the date of report.

*General Characteristics of Cases*

The distribution of cases by age, sex, race, and paralytic status is presented in table 3A, and related attack rates are presented in table 3C. The total attack rate for the 86 cases in the county is 139 per 100,000 population (based on 1950 census figures, table 3B). The total attack rate for white males is 180 per 100,000 population as compared to 123 for white females, the difference not being statistically significant. All patients were white except one. Of the total cases, 70, or 81 percent, were found to be paralytic.

**Table 4A. Distribution of total and of paralytic cases of poliomyelitis, by race, sex, and area of residence within Catawba County, N. C., 1953**

| Place of residence | Paralytic cases | | | | | | | Total cases | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | White | | | Nonwhite | | | Total | White | | | Nonwhite | | | Total |
| | Male | Female | Total | Male | Female | Total | | Male | Female | Total | Male | Female | Total | |
| Hickory | 5 | 6 | 11 | 0 | 0 | 0 | 11 | 5 | 8 | 13 | 0 | 0 | 0 | 13 |
| Newton | 9 | 4 | 13 | 0 | 0 | 0 | 13 | 11 | 5 | 16 | 0 | 0 | 0 | 16 |
| Rural | 30 | 15 | 45 | 0 | 1 | 1 | 46 | 34 | 22 | 56 | 0 | 1 | 1 | 57 |
| Catawba County | 44 | 25 | 69 | 0 | 1 | 1 | 70 | 50 | 35 | 85 | 0 | 1 | 1 | 86 |

**Table 4B. 1950 population, Catawba County, N. C.**

| Place of residence | White | | | Nonwhite | | | Total |
|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total | |
| Hickory | 5, 997 | 6, 594 | 12, 591 | 1, 008 | 1, 156 | 2, 164 | 14, 755 |
| Newton | 2, 624 | 2, 804 | 5, 428 | 302 | 309 | 611 | 6, 039 |
| Rural | 19, 153 | 19, 024 | 38, 177 | 1, 431 | 1, 392 | 2, 823 | 41, 000 |
| Catawba County | 27, 774 | 28, 422 | 56, 196 | 2, 741 | 2, 857 | 5, 598 | 61, 794 |

**Table 4C. Attack rates per 100,000 population, Catawba County, N. C.**

| Place of residence | Paralytic cases | | | | | | | Total cases | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | White | | | Nonwhite | | | Total | White | | | Nonwhite | | | Total |
| | Male | Female | Total | Male | Female | Total | | Male | Female | Total | Male | Female | Total | |
| Hickory | 83 | 91 | 87 | 0 | 0 | 0 | 75 | 83 | 121 | 103 | 0 | 0 | 0 | 88 |
| Newton | 343 | 143 | 239 | 0 | 0 | 0 | 215 | 419 | 178 | 295 | 0 | 0 | 0 | 265 |
| Rural | 157 | 79 | 118 | 0 | 72 | 35 | 112 | 178 | 116 | 147 | 0 | 72 | 35 | 139 |
| Catawba County | 158 | 88 | 123 | 0 | 35 | 18 | 113 | 180 | 123 | 151 | 0 | 35 | 18 | 139 |

Figure 1A. Total weekly poliomyelitis incidence rates per 100,000 population, Catawba County, N. C., 1953, by week of report, and paralytic status of cases, by week of onset.

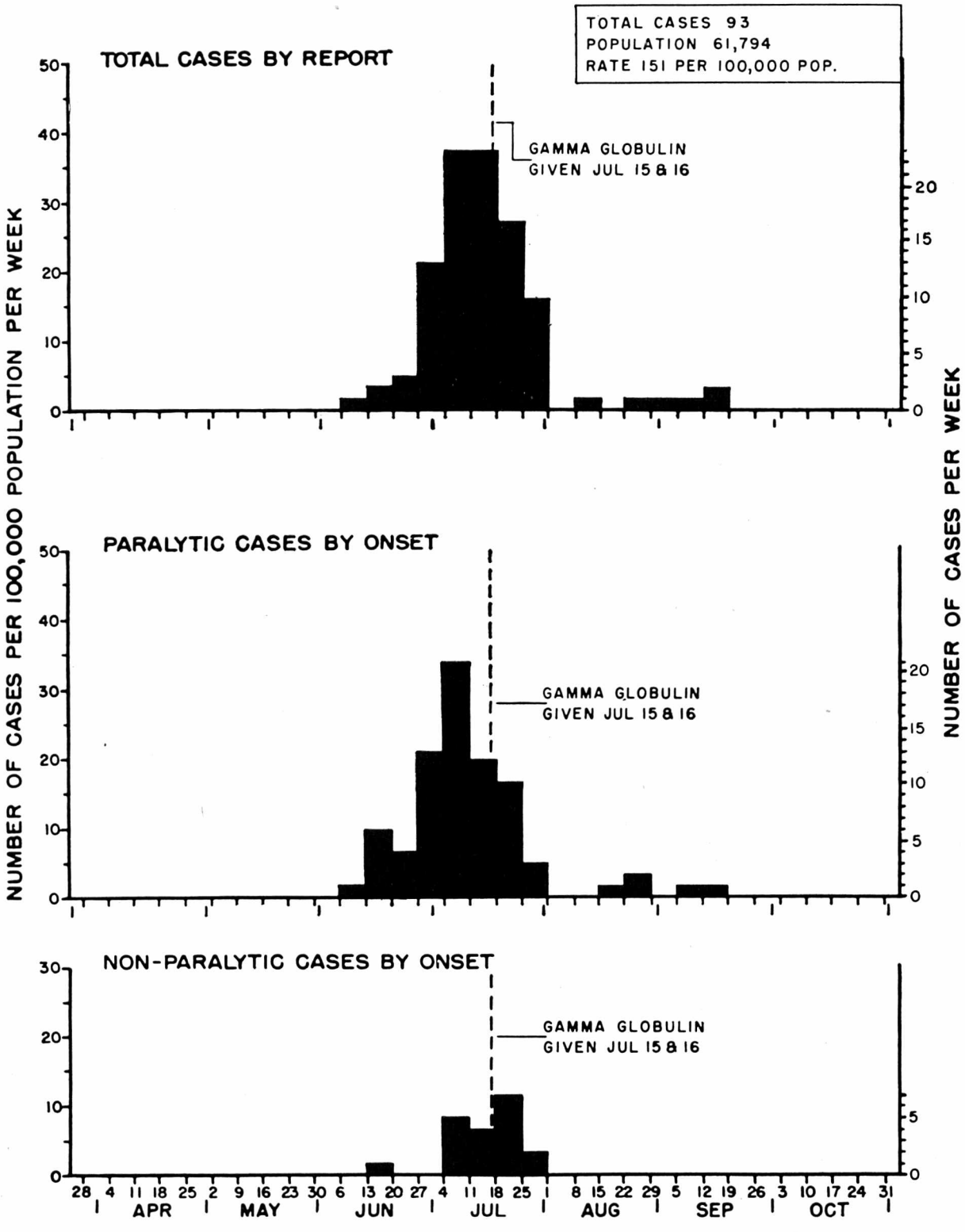

Figure 1B. Number of poliomyelitis cases, Catawba County, N. C., by week of onset, age group, and paralytic status.

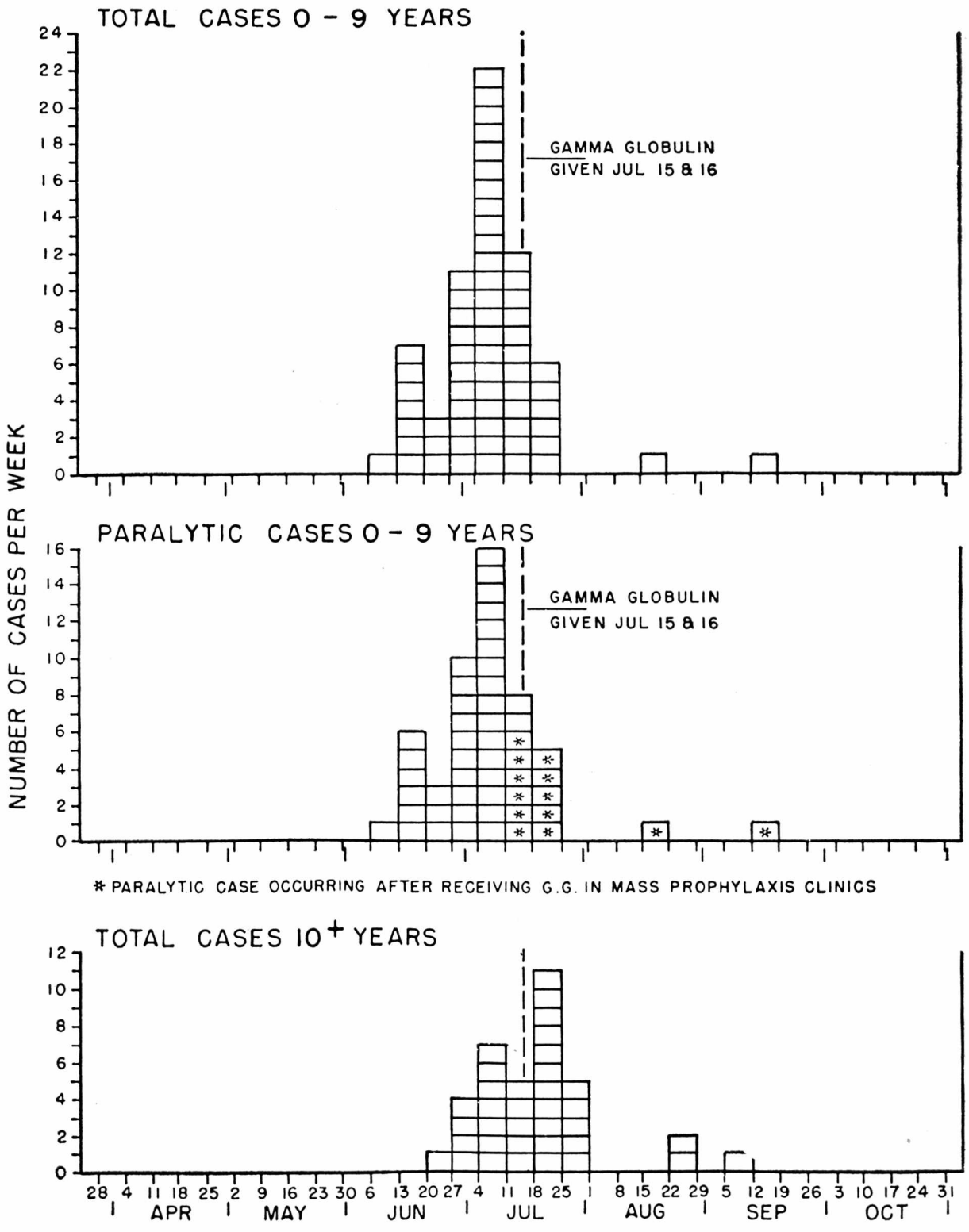

**Table 5. Summary of index and subsequent cases of poliomyelitis in multiple-case households,[1] Catawba County, N. C., 1953**

| Household accession No. | Person No. | Date of onset | Age | Sex | Diagnosis of paralysis 7–14 day examination | Percent involvement, 50–70 day physical therapist examination | Interval from index case (days) | Interval gamma globulin to onset (days) |
|---|---|---|---|---|---|---|---|---|
| | A. Index cases, none received gamma globulin | | | | | | | |
| 0009 | 8 | June 18 | 2 | F | P | 31. 7 | | |
| 0010 | 8 | July 8 | 5 | M | P | 9. 7 | | |
| 0011 | 3 | July 12 | 2 | F | P | [2] | | |
| 0014 | 4 | July 9 | 2 | M | P | 16. 0 | | |
| | B. Index cases, received gamma globulin | | | | | | | |
| 0013 | 6 | July 22 | 9 | M | P | 4. 3 | | 6 |
| | C. Subsequent cases, received gamma globulin | | | | | | | |
| 0013 | 8 | July 22 | 1 | M | P | 6. 8 | 0 | 6 |
| 0014 | 5 | July 16 | 4 | M | P | 3. 8 | 7 | 0 |
| | D. Subsequent cases, none received gamma globulin | | | | | | | |
| 0009 | 7 | June 18 | 4 | F | P | 12. 5 | 0 | |
| 0010 | 7 | July 8 | 5 | M | P | 10. 2 | 0 | |
| 0011 | 4 | July 14 | 3 | F | NP | 3. 8 | 2 | |
| 0013 | 3 | July 22 | 17 | F | P | 26. 8 | 0 | |

P=paralytic; NP=nonparalytic.

[1] Suspect cases not included.
[2] Expired 3 days after onset.

The distribution of cases by sex, race, status of paralysis, and place of residence is presented in table 4A, and related attack rates in table 4C. The total attack rates per 100,000 population is 88 for Hickory, 265 for Newton, and 139 for rural residents of Catawba County. The differences between these rates are statistically different by the Chi-square test, emphasizing the disproportionate number of cases found in Newton over the number found in the city of Hickory.

**Table 6. Interval in days between onset of index and subsequent cases in multiple-case households, Catawba County, N. C., 1953**

| Interval (days) | Total cases | Paralytic cases |
|---|---|---|
| 0 | 4 | 4 |
| 1 | 0 | 0 |
| 2 | 1 | 0 |
| 3 | 0 | 0 |
| 4 | 0 | 0 |
| 5 | 0 | 0 |
| 6 | 0 | 0 |
| 7 | 1 | 1 |
| Total | 6 | 5 |

*Special Characteristics of Cases*

Of the total cases, 13, or 15 percent, had histories of throat and mouth operations, injections, or other operations. This represents 14 percent of the paralytic cases and 19 percent of the nonparalytic cases. Three female cases were pregnant at the time of onset.

*Familial Aggregation*

The 5 multiple-case households total 11 cases, with 2 cases in 4 households and 3 cases in 1 household. A summary of index and subsequent cases is presented in table 5. A summary

**Table 7. Age-specific subsequent attack rates Catawba County, N. C., 1953**

| Age group | Number of household contacts of index cases | Number of subsequent cases | | Subsequent attack rate per 100,000 population | |
|---|---|---|---|---|---|
| | | Total | Paralytic | Total | Paralytic |
| Under 5 years | 64 | 4 | 3 | 6, 250 | 4, 688 |
| 5–9 years | 44 | 1 | 1 | 2, 273 | 2, 273 |
| 10 years and over | 246 | 1 | 1 | 407 | 407 |
| All ages | 354 | 6 | 5 | 1, 644 | 1, 374 |

of intervals between the index case and subsequent cases is shown in table 6.

The 6 subsequent cases represent a subsequent attack rate of 1,644 per 100,000 contacts (table 7). The subsequent attack rate for children under age 5 is 6,250 per 100,000 contacts. This is not significantly higher than the attack rate for children under age 5 of 5,198 per 100,000 population for the entire county.

*Appraisal of Effects of Gamma Globulin*

To evaluate the effect of gamma globulin in modifying the severity of disease, 50–70 day muscle examinations were conducted by a physical therapist on three groups of cases:

1. Cases whose onsets fell within the week July 8–14, who did not receive gamma globulin (table 8A).
2. Cases whose onsets fell on July 15, or thereafter, who did not receive gamma globulin (table 8B).
3. Cases whose onsets fell on July 15, or

**Table 8. Summary of three groups of cases of poliomyelitis, age 9 and under, in single-case households who received 50–70 day muscle examinations,[1] Catawba County, N. C., 1953**

| Household accession No. | Person No. | Date of onset | Age | Sex | Diagnosis of paralysis (7–14 day examination) | 50–70 day examination | | Interval gamma globulin to onset of poliomyelitis (days) |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Percent involvement | Bulbar involvement | |
| | A. All cases whose onsets fell in the week July 8–July 14, did not receive gamma globulin | | | | | | | |
| 1141 | 5 | July 10 | 2 | F | P | 2. 1 | No | |
| 1142 | 5 | July 11 | 3 | M | P | 7. 9 | No | |
| 1153 | 8 | July 9 | 2 | M | P | 18. 3 | No | |
| 1161 | 5 | July 8 | 3 | F | P | 17. 1 | No | |
| 1163 | 5 | July 13 | 6 | M | NP | 1. 4 | Yes | |
| 1188 | 4 | July 11 | 3 | M | P | 37. 0 | Yes | |
| 1189 | 5 | July 8 | 6 | F | NP | 8. 0 | Yes | |
| 1200 | 4 | July 11 | 1 | M | P | 2. 8 | No | |
| | B. All cases whose onsets fell on July 15 or thereafter, did not receive gamma globulin | | | | | | | |
| 1169 | 4 | 7–15 | 9 | M | P | 2. 6 | No | |
| | C. All cases whose onsets fell on July 15 or thereafter, did receive gamma globulin | | | | | | | |
| 1124 | 4 | July 16 | 2 | F | P | 11. 1 | Yes | 1 |
| 1133 | 5 | July 20 | 6 | M | NP | 2. 3 | No | 5 |
| 1136 | 9 | July 17 | 2 | F | P | 11. 2 | No | 2 |
| 1155 | 4 | July 18 | 8 | M | NP | 0. 0 | No | 3 |
| 1184 | 7 | July 17 | 2 | M | P | 5. 6 | No | 1 |
| 1191 | 4 | July 19 | 4 | M | P | 2. 8 | No | 11 |
| 1194 | 3 | July 19 | 2 | F | P | 3. 2 | No | 3 |
| 1197 | 3 | July 25 | 4 | M | P | 3. 4 | Yes | 9 |

P=paralytic; NP=nonparalytic.

[1] Cases receiving gamma globulin on day of onset, or thereafter, not included.



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**Table 9. Distribution of average percentage involvements for three groups of cases in single-case households having 50–70 day muscle examinations, Catawba County, N. C., 1953**

| 7–14 day diagnosis | Onset July 8–14 (no gamma globulin) | | Onset July 15 and thereafter (no gamma globulin) | | Onset July 15 and thereafter (gamma globulin) | |
|---|---|---|---|---|---|---|
| | Number of cases | Average involvement (Percent) | Number of cases | Average involvement (Percent) | Number of cases | Average involvement (Percent) |
| Paralytic | 6 | 14. 2 | 1 | 2. 6 | 6 | 6. 2 |
| Nonparalytic | 2 | 4. 7 | 0 | ---------- | 2 | 1. 2 |
| All cases | 8 | 11. 8 | 1 | 2. 6 | 8 | 5. 0 |

thereafter, who received gamma globulin (table 8C).

Only cases under age 10 were included in these groups. Data on 17 of 18 such cases were successfully obtained. Of these 17 cases, bulbar involvement was noted in 2 cases or 12 percent of the cases in the 7–14 day examination, as compared with 5 cases, or 29 percent of the cases found in the 50–70 day muscle examination by the physical therapist.

Since there was only one case in group 2, comparisons are limited to groups 1 and 3. A crude statistic, the average percent involvement, was used in comparing the groups; its crudeness derived from the large variation in the percent involvement of cases in the groups (table 9).

The 8 cases in group 1 have an average percent involvement of 11.8 percent. The 8 cases in group 3 (the group receiving gamma globulin) have an average percent involvement of 5.0 percent. In classifying the cases according to their 7–14 day diagnosis, it can be seen that the 6 cases in group 1, diagnosed as paralytic, have an average percent involvement of 14.2 percent, while the 6 cases in group 3, diagnosed as paralytic, have an average percent involvement of 6.2 percent.

While these statistics are compatible with the hypothesis that gamma globulin modified the severity of disease, the data are not sufficient to attach statistical significance to any conclusions.

## Summary

A description of an epidemic of 86 cases of poliomyelitis occurring in Catawba County, N. C., with onsets between June 7 and July 31, 1953, is presented. The total attack rate for the county was 139 per 100,000 population, and the city of Newton had an attack rate of 265 per 100,000 population. The peak of the fairly symmetric distribution fell during the week ending July 11. On July 15 and 16, gamma globulin was administered to 14,786 children in the mass prophylaxis program. Though there was a noticeable shift in ages of cases in the last weeks of the epidemic, there is little evidence to conclude that the mass prophylaxis of gamma globulin altered the course of the epidemic.

Muscle evaluation data were analyzed to investigate the effect of gamma globulin on the paralytic disease. Though results are suggestive, no statistically valid conclusions could be drawn.

## Sullivan County and Bristol, Tennessee, and Washington County and Bristol, Virginia

On July 22, 1953, Dr. Cecil Tucker, director of the division of preventable diseases, Tennessee Department of Public Health, and Dr. M. I. Shanholtz, commissioner of health, Virginia Department of Health, requested the services of an epidemiologic team to assist in the investigation of an outbreak of poliomyelitis then occurring in Sullivan County and Bristol, Tenn., and in Washington County and Bristol, Va.

Between April 1 and July 22, 66 cases had been reported from this area, about one-third of them from Bristol alone. Approximately 60 percent of the patients were reported as being paralyzed.

A team composed of Dr. Heinz Eichenwald, Epidemic Intelligence Service officer in charge, and Dr. Martin Keller, EIS officer, was assigned to Drs. Tucker and Shanholtz, and through them to the local health departments in this area. The team arrived in the area on July 26, and met Dr. J. W. Erwin, Sullivan County health officer, and Dr. James Suter, acting director of health for the southwest district of Virginia. The epidemiologic investigation was carried out from July 26–31, with a return visit to the area by Dr. Eichenwald on August 21 and by Dr. Keller on September 22.

Due to the fact that the two counties and Bristol are geographically contiguous and represent a single epidemic region, this report will deal with all three areas. Bristol will be considered for the most part as a unit, instead of its two political subdivisions.

### Area and Poliomyelitis History

The area embraces the northeastern portion of Tennessee and the southwestern tip of Virginia. Sullivan County, Tenn., borders on Washington County, Va., on the north, and on Carter County, Tenn., in the southeast. Washington County borders Smyth County on the northeast and Ashe County, N. C., on the southeast. Bristol is located roughly in the center of the area astride the Virginia-Tennessee State line, which politically divides it into the two geographically and economically contiguous cities of Bristol, Va., and Bristol, Tenn. Bristol, Va., has the status of an independent city, while its Tennessee counterpart forms a part of Sullivan County.

Washington County, Va., has a population of 37,536 with 3 percent nonwhites (1950 census); Sullivan County, Tenn., exclusive of Bristol, numbers 78,291 with 2.5 percent nonwhites; Bristol, Tenn., has 16,771 inhabitants and Bristol, Va., has 15,954, both with approximately 7 percent nonwhites.

The population increase for Sullivan County for the period 1940 to 1950 was 37.6 percent, while it was only 2 percent for Washington County for the same period. Bristol, Tenn., gained 19.4 percent, but its twin city increased 63 percent in the same 10-year period. The population increase in Bristol was chiefly due to the influx of workers employed in the many new industries manufacturing a wide variety of products. A large part of the total income of the two counties is derived directly or indirectly from these industries. However, in the rural areas, there is also a great deal of farming and cattle raising. Because of the mild summer climate and pleasantly hilly terrain, many tourists are attracted to the area.

The poliomyelitis incidence since 1944 is presented in tables 1 and 2; separate data for either half of Bristol were not available. Until this year, only paralytic poliomyelitis was reportable in Tennessee, so the figures from Sullivan County indicate only the incidence of paralytic disease. During this time period, the largest outbreak in Sullivan County was in 1947 when 23 paralytic cases were reported, resulting in an attack rate of 26.4 cases per 100,000 population. This outbreak did not spread into Washington County, Va., which recorded its peak year 3 years later when 21 cases occurred, resulting in an attack rate of 39.3 cases per 100,000 population.

Seasonal peaks in this area are usually reached in the last week of August or the first 2 weeks of September. However, in Sullivan County last year the peaks occurred in November, when 6 cases (one-third the total number for

**Table 1. Number and rate of reported cases of paralytic poliomyelitis, Sullivan County, including Bristol, Tenn., 1944–52**

| Year | Population | Number of paralytic cases | Attack rate per 100,000 population |
|---|---|---|---|
| 1944 | 79, 476 | 10 | 12. 6 |
| 1945 | 82, 074 | 1 | 1. 2 |
| 1946 | 84, 672 | 3 | 3. 5 |
| 1947 | 87, 270 | 23 | 26. 4 |
| 1948 | 89, 867 | 5 | 5. 6 |
| 1949 | 92, 465 | 4 | 4. 3 |
| 1950 | 95, 063 | 11 | 11. 6 |
| 1951 | 97, 661 | 9 | 9. 2 |
| 1952 | 100, 258 | 18 | 18. 0 |

the year) were recorded, with an additional case in December. There was nothing unusual about last year's distribution of cases in Washington County.

## Reporting, Diagnosis, and Hospitalization

Cases were reported over the telephone by physicians directly to the local health authority, giving age, sex, race, address, date of onset, and sometimes the type of involvement. A county public health nurse promptly visited the household. A number of the more doubtful cases were seen by the health officers to confirm the diagnosis.

About 85 percent of the reported paralytic cases and about one-half of the nonparalytic patients were hospitalized. Most of the nonparalytic patients had spinal fluid examinations either in a hospital or in the doctor's office.

The Sullivan County and Bristol, Tenn., area is served by three hospitals: Bristol Memorial Hospital in Bristol, Johnson City Memorial Hospital in Johnson City, and Holston Valley Community Hospital in Kingsport. These institutions also admitted patients from Washington County, Va., but many of the latter group were cared for in the Johnston Memorial Hospital in Abingdon, Va.

## Administration of Gamma Globulin

In all three areas gamma globulin was available to all household contacts up to and including age 19, and to pregnant women of any age. Injections were usually given by the attending physicians within 2 days after the index case had been recognized and reported. In order to obtain the gamma globulin, a requisition card had to be filed with the health department, listing the name and address of the index case, the date of onset, the names and addresses of the family contacts and their ages and weights. The required amount of the gamma globulin was then made available. A number of the injections were given by the health department personnel.

Because of the rising incidence of reported cases of poliomyelitis in Bristol and Washington County, Va., the entire city and the county were certified for community gamma globulin prophylaxis on July 17. On the other hand, Sullivan County, Tenn., exclusive of Bristol, did not qualify for gamma globulin prophylaxis.

The gamma globulin was available for children aged 6 months through 9 years. The inoculations were given during a 2-day period on July 22 and 23, with approximately 13,000 doses being administered in Washington County and Bristol, Va., and an additional 6,000 doses in Bristol, Tenn.

## Epidemiologic Investigation

From July 26 to July 31, general epidemiologic information about such reported cases was obtained, special emphasis being placed on the verification of dates of onset and of the diagnosis of the nonparalytic cases. This necessitated home visits to interview the parents of many of the cases, a review of pertinent hospital records, examination and muscle-grading of patients, and interviews

**Table 2. Number and rate of reported cases of poliomyelitis, Washington County, including independent city of Bristol, Va., 1944–52**

| Year | Population | Number of cases | Attack rate per 100,000 population |
|---|---|---|---|
| 1944 | 50, 175 | 11 | 21. 9 |
| 1945 | 50, 728 | 1 | 2. 0 |
| 1946 | 51, 280 | N. R. | N. R. |
| 1947 | 51, 833 | 7 | 13. 5 |
| 1948 | 52, 385 | 2 | 3. 8 |
| 1949 | 52, 938 | 4 | 7. 6 |
| 1950 | 53, 490 | 21 | 39. 3 |
| 1951 | 54, 043 | 2 | 3. 7 |
| 1952 | 54, 595 | 6 | 11. 0 |

with attending physicians and physical therapists. Followup visits were made to the county on August 21 and on September 22, to obtain similar information on the cases reported in the interval.

*Distribution of Cases in Time*

From April 1 to August 21, 1953, a total of 138 cases of poliomyelitis was reported from this area. Of these, 59 cases were reported from Washington County, Va., 16 from Bristol, Va., 34 from Bristol, Tenn., and 29 from the remainder of Sullivan County, Tenn. The investigation indicated that 3 patients in Washington County were definitely not ill with poliomyelitis, and in 5 other children, diagnosed by their physicians as having the "abortive" type of poliomyelitis, the clinical history was inconclusive and there were no positive spinal fluid findings. The latter 5 patients are, therefore, classified as "suspect" and are not included in this analysis. Five patients residing in Wash-

**Table 3. Distribution of total cases and paralytic cases of poliomyelitis, by week of onset, Bristol, Va. and Tenn., Sullivan County, Tenn., and Washington County, Va.**

| Week | Bristol, Va. and Tenn. | | Sullivan County, Tenn., exclusive of Bristol | | Washington County, Va. | |
|---|---|---|---|---|---|---|
| | Paralytic | Total | Paralytic | Total | Paralytic | Total |
| April 19–23 | 1 | 1 | 0 | 0 | 0 | 0 |
| June 14–20 | 1 | 1 | 0 | 0 | 0 | 0 |
| June 21–27 | 0 | 1 | 1 | 1 | 0 | 0 |
| June 28–July 4 | 1 | 1 | 2 | 3 | 2 | 3 |
| July 5–11 | 4 | 6 | 1 | 1 | 6 | 7 |
| July 12–18 | 7 | 9 | 2 | 3 | 9 | 14 |
| July 19–25 | 6 | 8 | 2 | 3 | 5 | 10 |
| July 26–August 1 | 4 | 7 | 6 | 6 | 1 | 3 |
| Aug. 2–8 | 1 | 3 | 0 | 1 | 2 | 3 |
| Aug. 9–15 | 0 | 3 | 0 | 2 | 3 | 3 |
| Aug. 16–22 | 4 | 7 | 0 | 2 | 2 | 4 |
| Aug. 23–29 | 1 | 2 | 0 | 0 | 3 | 3 |
| Aug. 30–Sept. 5 | 0 | 0 | 3 | 4 | 0 | 0 |
| Sept. 6–12 | 1 | 1 | 0 | 0 | 0 | 0 |
| Sept. 13–19 | 0 | 0 | 1 | 1 | 0 | 0 |
| Sept. 20–26 | 0 | 0 | 2 | 2 | 0 | 0 |
| Sept. 27–Oct. 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| Oct. 4–10 | 0 | 0 | 0 | 0 | 0 | 0 |
| Oct. 11–17 | 0 | 0 | 0 | 0 | 1 | 1 |
| Total | 31 | 50 | 20 | 29 | 34 | 51 |

**Table 4. Attack rates of poliomyelitis per 100,000 population by sex and race, Bristol, Va. and Tenn., Sullivan County, Tenn., and Washington County, Va.**

| Race and sex | Bristol, Va. and Tenn. | | | Sullivan County, Tenn. (exclusive of Bristol) | | | Washington County, Va. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Population | Cases | Rate | Population | Cases | Rate | Population | Cases | Rate |
| White male | 14, 272 | 25 | 175. 1 | 37, 694 | 19 | 50. 4 | 18, 442 | 27 | 146. 4 |
| White female | 16, 439 | 17 | 103. 4 | 39, 183 | 9 | 23. 0 | 17, 879 | 23 | 128. 6 |
| Nonwhite male | 1, 177 | 7 | 594. 7 | 672 | 1 | [1] | 647 | 1 | [1] |
| Nonwhite female | 1, 181 | 1 | [1] | 742 | 0 | 0 | 568 | 0 | 0 |
| White population | 30, 711 | 42 | 136. 7 | 76, 877 | 28 | 36. 4 | 36, 321 | 50 | 137. 6 |
| Nonwhite population | 2, 358 | 8 | 339. 2 | 1, 414 | 1 | [1] | 1, 215 | 1 | [1] |
| Total population | 33, 069 | 50 | 151. 1 | 78, 291 | 29 | 37. 0 | 37, 536 | 51 | 135. 8 |

[1] Rates not calculated because numbers are too small.

**Table 5A. Number of cases of poliomyelitis, by age group, sex, race,[1] and paralytic status, Washington County, Va.**

| Age group | Population | | Paralytic cases | | Total cases | | Paralytic cases per 100,000 population | | Total cases per 100,000 population | |
|---|---|---|---|---|---|---|---|---|---|---|
| | White male | White female | White male | White female | White male | White female | White male | White female | White male | White female |
| <1 year | 390 | 361 | 1 | 2 | 1 | 2 | 256 | 554 | 256 | 554 |
| 1–4 years | 1, 858 | 1, 678 | 4 | 5 | 5 | 7 | 215 | 298 | 269 | 417 |
| 5–9 years | 2, 124 | 1, 959 | 3 | 4 | 7 | 6 | 141 | 204 | 330 | 306 |
| 10–14 years | 2, 025 | 1, 844 | 5 | 4 | 8 | 4 | 247 | 217 | 395 | 217 |
| 15+ years | 12, 045 | 12, 037 | 4 | 2 | 6 | 4 | 33. 2 | 16. 6 | 49. 8 | 33. 2 |
| Total | 18, 442 | 17, 879 | 17 | 17 | 27 | 23 | | | | |

[1] One nonwhite case, age 20, male, paralytic, excluded.

**Table 5B. Number of cases of poliomyelitis, by age group, sex, race,[1] and paralytic status, Sullivan County, Tenn., exclusive of Bristol**

| Age group | Population | | Paralytic cases | | Total cases | | Paralytic cases per 100,000 population | | Total cases per 100,000 population | |
|---|---|---|---|---|---|---|---|---|---|---|
| | White male | White female | White male | White female | White male | White female | White male | White female | White male | White female |
| <1 year | 859 | 844 | 1 | 0 | 1 | 0 | 116 | 0 | 116 | 0 |
| 1–4 years | 3, 981 | 3, 911 | 4 | 2 | 4 | 4 | 101 | 51. 1 | 101 | 102 |
| 5–9 years | 4, 310 | 4, 115 | 2 | 2 | 4 | 2 | 46. 4 | 48. 6 | 92. 8 | 48. 6 |
| 10–14 years | 3, 674 | 3, 567 | 3 | 0 | 5 | 1 | 81. 7 | 0 | 136 | 28. 0 |
| 15+years | 24, 870 | 26, 746 | 4 | 1 | 5 | 2 | 16. 1 | 3. 7 | 20. 1 | 7. 5 |
| Total | 37, 694 | 39, 183 | 14 | 5 | [1] 19 | 9 | | | | |

[1] There was 1 nonwhite case, age 3, male, nonparalytic.

**Table 5C. Number of cases of poliomyelitis, by age group, sex, race, and paralytic status, Bristol, Va. and Tenn., 1953**

| Age group | Population | | | | Paralytic cases | | | | Total cases | |
|---|---|---|---|---|---|---|---|---|---|---|
| | White | | Nonwhite | | White | | Nonwhite | | White | |
| | Male | Female | Male | Female | Male | Female | Male | Female | Male | Female |
| <1 year | 348 | 329 | 23 | 18 | 1 | 0 | 0 | 0 | 1 | 0 |
| 1–4 years | 1, 326 | 1, 302 | 84 | 88 | 8 | 6 | 4 | 0 | 10 | 7 |
| 5–9 years | 1, 430 | 1, 324 | 91 | 92 | 4 | 1 | 1 | 1 | 5 | 3 |
| 10–14 years | 1, 187 | 1, 217 | 74 | 69 | 3 | 4 | 0 | 0 | 5 | 5 |
| 15+ years | 9, 981 | 12, 267 | 905 | 914 | 0 | 0 | 0 | 0 | 4 | 2 |
| Total | 14, 272 | 16, 439 | 1, 177 | 1, 181 | 16 | 11 | 5 | 1 | 25 | 17 |

**Table 5C. Number of cases of poliomyelitis, by age group, sex, race, and paralytic status, Bristol, Va. and Tenn., 1953—Continued**

| Age group | Total cases | | Paralytic cases per 100,000 population | | | | Total cases per 100,000 population | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Nonwhite | | White | | Nonwhite | | White | | Nonwhite | |
| | Male | Female | Male | Female | Male | Female | Male | Female | Male | Female |
| <1 year | 0 | 0 | 287 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1–4 years | 4 | 0 | 603 | 461 | 4, 762 | 0 | 754 | 538 | 4, 762 | 0 |
| 5–9 years | 2 | 1 | 280 | 75. 5 | 1, 099 | 1, 087 | 350 | 227 | 2, 198 | 1, 087 |
| 10–14 years | 1 | 0 | 253 | 329 | 0 | 0 | 421 | 411 | 1, 351 | 0 |
| 15+ years | 0 | 0 | 0 | 0 | 0 | 0 | 40. 1 | 16. 3 | 0 | 0 |
| Total | 7 | 1 | | | | | | | | |

**Table 5D. Number of cases of poliomyelitis, by age group, sex, race, and paralytic status, Bristol, Va.**

| Age group | Population | | | | Number of paralytic cases | | | | Total number of cases | | | | Attack rate per 100,000 total population |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | White | | Nonwhite | | White | | Nonwhite | | White | | Nonwhite | | |
| | Male | Female | Male | Female | Male | Female | Male | Female | Male | Female | Male | Female | |
| <1 year | 159 | 153 | 14 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1–4 years | 630 | 648 | 49 | 53 | 3 | 4 | 1 | 0 | 4 | 4 | 1 | 0 | 652 |
| 5–9 years | 705 | 658 | 55 | 55 | 3 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 204 |
| 10–14 years | 632 | 639 | 41 | 44 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 147 |
| 15+ years | 4, 672 | 5, 933 | 525 | 600 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 17. 1 |
| Total | 6, 798 | 8, 031 | 684 | 761 | 6 | 5 | 1 | 0 | 9 | 6 | 1 | 0 | |

**Table 5E. Cases of poliomyelitis, by age group, sex, race, and paralytic status, Bristol, Tenn., 1953**

| Age group | Population | | | | Paralytic cases | | | | Total cases | | | | Attack rate per 100,000 population |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | White | | Nonwhite | | White | | Nonwhite | | White | | Nonwhite | | |
| | Male | Female | Male | Female | Male | Female | Male | Female | Male | Female | Male | Female | |
| <1 year | 189 | 176 | 9 | 9 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 261 |
| 1–4 years | 696 | 654 | 35 | 35 | 5 | 2 | 3 | 0 | 6 | 3 | 3 | 0 | 845 |
| 5–9 years | 725 | 666 | 36 | 37 | 1 | 1 | 1 | 1 | 2 | 3 | 2 | 1 | 546 |
| 10–14 years | 555 | 578 | 33 | 25 | 3 | 3 | 0 | 0 | 4 | 4 | 1 | 0 | 756 |
| 15+ years | 5, 309 | 6, 334 | 380 | 314 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 32. 4 |
| Total | 7, 474 | 8, 408 | 493 | 420 | 10 | 6 | 4 | 1 | 16 | 11 | 6 | 1 | |

**Table 6. Interval in days between onsetof first and, subsequent cases in multiple-case households (Sullivan County, Tenn., Washington County, Va. and Bristol, Va.–Tenn.)**

| Interval days | Total cases | Paralytic cases |
|---|---|---|
| 0 | 1 | 1 |
| 1 | 0 | 0 |
| 2 | 0 | 0 |
| 3 | 2 | 1 |
| 4 | 0 | 0 |
| 5 | 1 | 1 |
| 6 | 1 | 1 |
| 7 | 2 | 2 |

ington County died from their disease, each half of Bristol had one fatality, and there were no deaths in Sullivan County. It is of interest that about one-third of the paralytic cases from this whole area were noted to have some degree of bulbar involvement.

The first case in the outbreak occurred toward the end of April in Sullivan County, about 40 miles away from Bristol. It was not until the last week in June, however, that a progressive rise in cases began simultaneously in Bristol and Sullivan and Washington Counties. A peak was reached toward the end of the third week of July in Bristol and in Washington County; in the Sullivan County rural area this occurred a week later. The number of patients then rapidly diminished.

It is of interest that during the first 3 weeks of the outbreak in Sullivan County, Tenn., 14 of the 17 cases came from Bristol, or its immediate vicinity. After that time the city-county distribution of patients became equalized. Table 3 lists the dates of onset of total and of paralytic cases for each area.

The ratio of paralytic to nonparalytic patients remained generally stable throughout the course of the outbreak.

### *Distribution of Cases by Age, Race, and Area of Residence*

The attack rate in Bristol as a whole was 151.1 per 100,000 population. When the data from each half of the twin city were analyzed separately, the rate in Tennessee was 202.7, and in Virginia 100.3. The reasons for this disparity are not apparent, since the cases were scattered throughout each half with no foci in evidence. Sullivan County's rate of 37.0 (exclusive of Bristol) was one-fourth that of its neighbor, Washington County.

Table 4 shows the distribution of cases by sex and race for each area. The attack rate in the nonwhite population is significantly higher than in the white population. The apparent differences in rates between the two sexes are not significant. In tables 5A, B, C, D, and E, the data are further broken down by age group, sex, race, and type of involvement. In all areas

**Table 7. Summary of subsequent cases in multiple-case households, Bristol, Va.–Tenn., Sullivan County, Tenn., and Washington County, Va., 1953**

| Initials of patient | Date of onset | Interval from index case to onset (days) | Date gamma globulin administered | Paralytic status |
|---|---|---|---|---|
| | A. Cases receiving gamma globulin | | | |
| C. C | July 18 | 6 | July 17 | Paralyzed. |
| P. C | July 30 | 7 | July 29 | Do. |
| | B. Cases not receiving gamma globulin | | | |
| P. G | July 12 | 0 | ---------- | Paralyzed. |
| J. B | July 21 | 3 | ---------- | Do. |
| L. B | July 21 | 3 | ---------- | Not paralyzed. |
| M. R | Aug. 22 | 5 | ---------- | Paralyzed. |
| E. C | July 10 | 7 | ---------- | Not paralyzed. |

patients aged 1–9 years had the highest attack rate. The ratio of paralytic to nonparalytic cases did not differ significantly by age groups or by area of residence. A sharp drop in attack rate among patients aged 15 years and over is evident in the city as well as in the counties.

### *Familial Aggregation*

In the study area there were 6 multiple-case households, 5 with 2 cases each, and 1 with 3 cases, a total of 13 individuals. Only 2 of the 7 subsequent patients received gamma globulin and in both, the injection was given only 1

**Table 3. Summary of all cases with onsets after the mass inoculation of gamma globulin on July 22 and 23, Washington County, Va. and Bristol, Va. and Tenn.**

| Initials of patient | Age | Date of onset | Paralytic status | Interval gamma globulin to onset |
|---|---|---|---|---|
| | A. Those receiving gamma globulin | | | |
| C. W. | 3 | July 23 | Nonparalytic | 1 |
| D. B. | 13 mo. | July 23 | Paralytic | 1 |
| D. M. | 8 | July 23 | Nonparalytic | 1 |
| D. T. | 8 | July 25 | Paralytic | 2 |
| C. M. | 9 | July 29 | Nonparalytic | 6 |
| J. F. | 11 mo. | Aug. 1 | Paralytic | 10 |
| G. F. | 2 | Aug. 6 | do | 15 |
| M. K. | 2 | Aug. 11 | do | 20 |
| T. C. | 8 mo. | Aug. 16 | do | 25 |
| S. T. | 8 | Aug. 18 | Nonparalytic | 27 |
| T. A. | 8 mo. | Aug. 21 | Paralytic (expired) | 29 |
| J. N. | 4 | Aug. 23 | Paralytic | 32 |
| J. W. | 4 | Aug. 26 | do | 35 |
| R. B. | 5 | Sept. 9 | do | 49 |
| | B. Those not receiving gamma globulin | | | |
| D. F. | 12 | July 25 | Nonparalytic | |
| E. F. | 16 | July 25 | do | |
| E. P. | 13 | July 25 | do | |
| B. P. | 2 | July 26 | Paralytic | |
| M. S. | 14 | July 26 | Paralytic (expired July 28) | |
| M. G. | 33 | July 27 | Paralytic | |
| M. M. | 15 | July 27 | Nonparalytic | |
| P. C. | 13 | July 30 | do | |
| D. G. | 12 | July 31 | Paralytic | |
| R. P. | 17 | Aug. 1 | Nonparalytic | |
| J. B. | 30 | Aug. 1 | do | |
| J. F. | 11 mo. | Aug. 1 | Paralytic | |
| C. C. | 40 | Aug. 6 | Nonparalytic | |
| H. H. | 10 | Aug. 8 | Paralytic | |
| W. P. | 37 | Aug. 11 | Nonparalytic | |
| W. W. | 38 | Aug. 11 | do | |
| H. K. | 29 | Aug. 11 | do | |
| J. G. | 18 | Aug. 12 | do | |
| G. R. | 20 | Aug. 15 | Paralytic (expired Aug. 18) | |
| T. H. | 6 | Aug. 16 | Paralytic | |
| J. H. | 28 | Aug. 16 | Nonparalytic | |
| S. T. | 11 | Aug. 16 | do | |
| J. W. | 20 | Aug. 16 | Paralytic | |
| P. R. | 13 | Aug. 17 | Nonparalytic | |
| C. W. | 11 | Aug. 20 | Paralytic | |
| D. W. | 11 | Aug. 20 | do | |
| I. M. | 14 mo. | Aug. 22 | do | |
| M. R. | 3 | Aug. 22 | do | |
| C. N. | 5 mo. | Aug. 23 | do | |
| C. G. | 16 | Aug. 28 | do | |
| E. R. | 12 | Aug. 29 | do | |
| B. W. | 17 | Oct. 12 | do | |



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Figure 1A. Total weekly poliomyelitis incidence rates per 100,000 population, Bristol, Va. and Tenn., 1953, by week of onset and paralytic status.

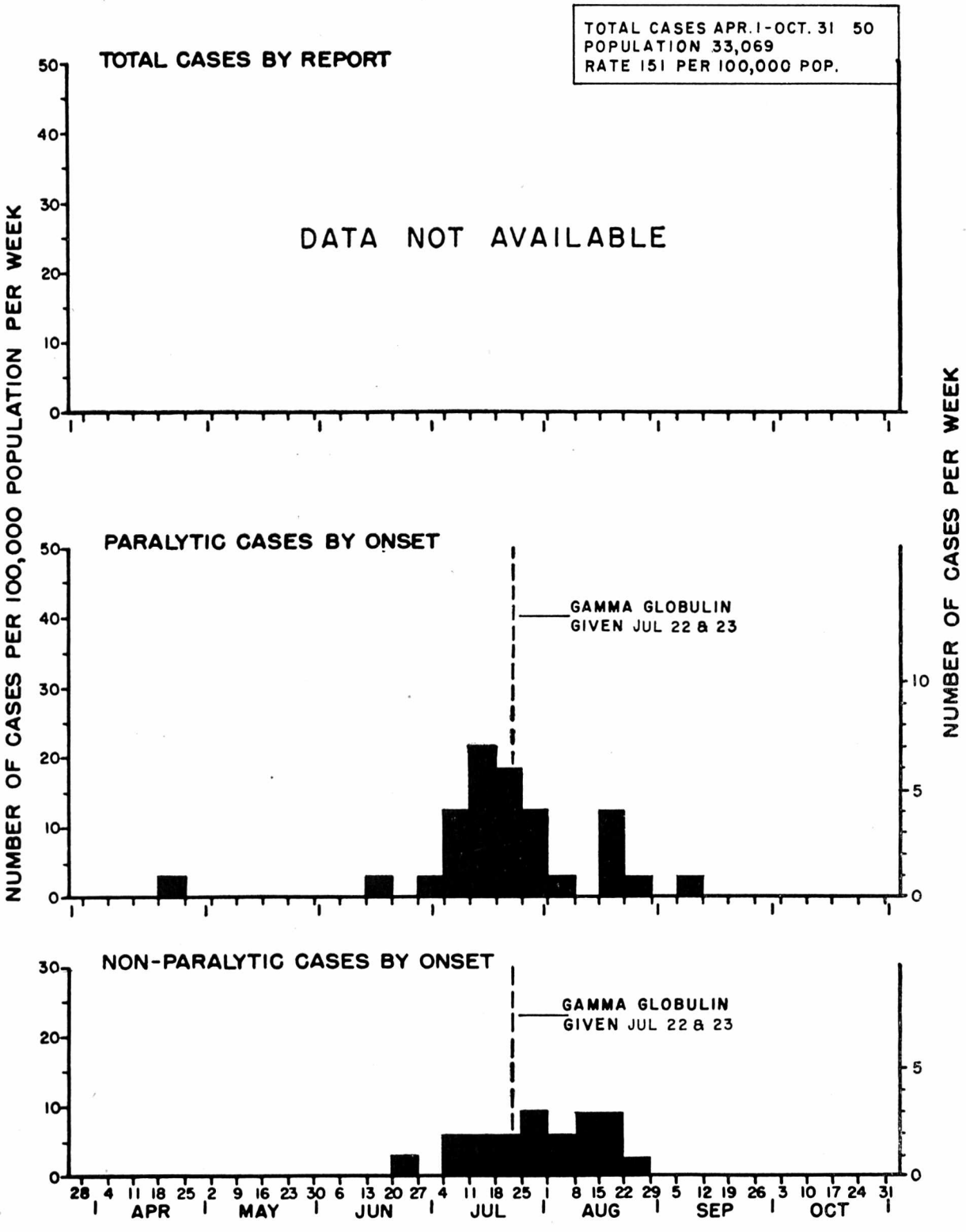


Figure 1B. Number of poliomyelitis cases, Bristol, Va. and Tenn., 1953, by week of onset, age group, and paralytic status.

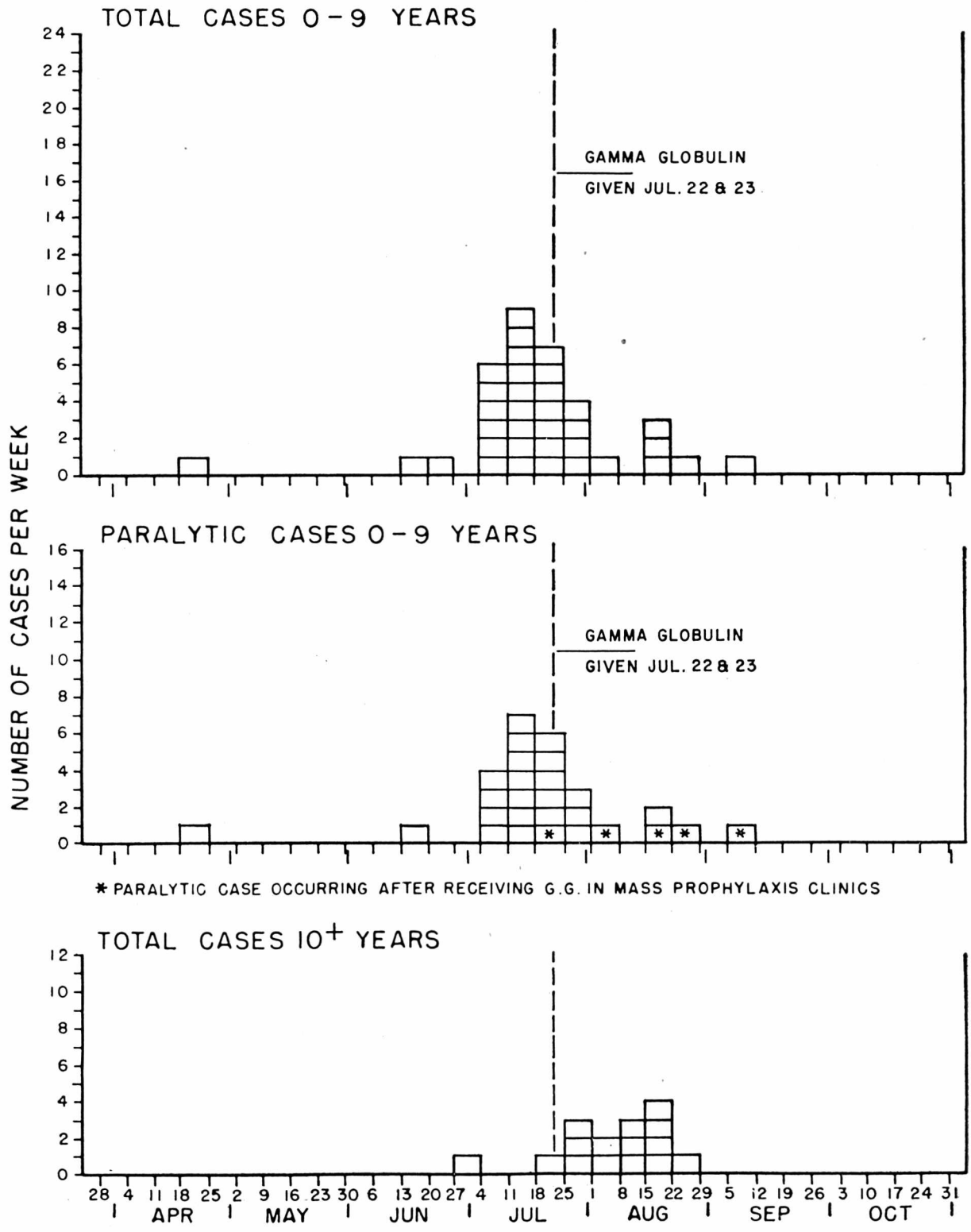


Figure 2A. Total weekly poliomyelitis incidence rates per 100,000 population, Washington County, Va., 1953, by week of onset and paralytic status.

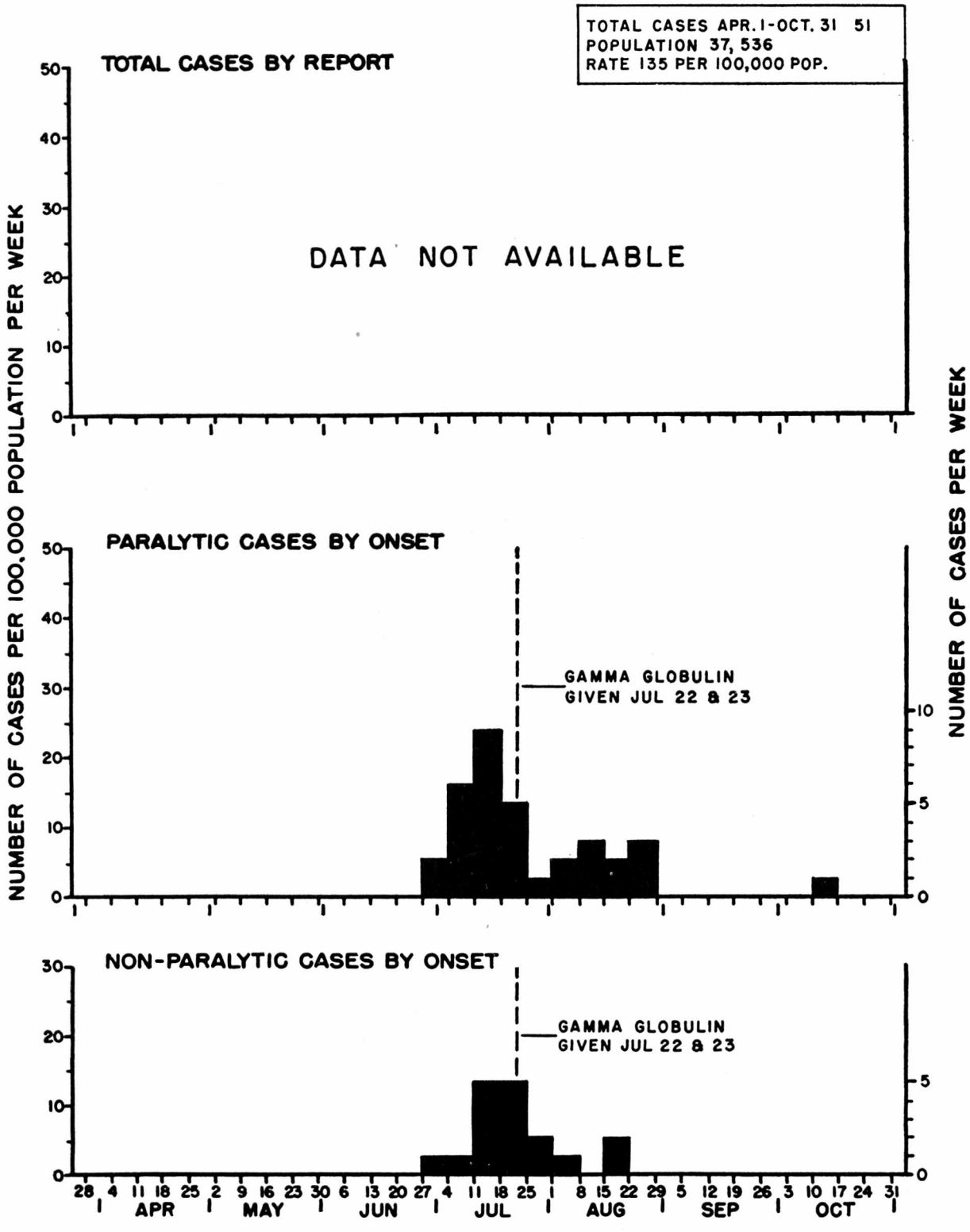


Figure 2B. Number of poliomyelitis cases, Washington County, Va., 1953, by week of onset, age group, and paralytic status.

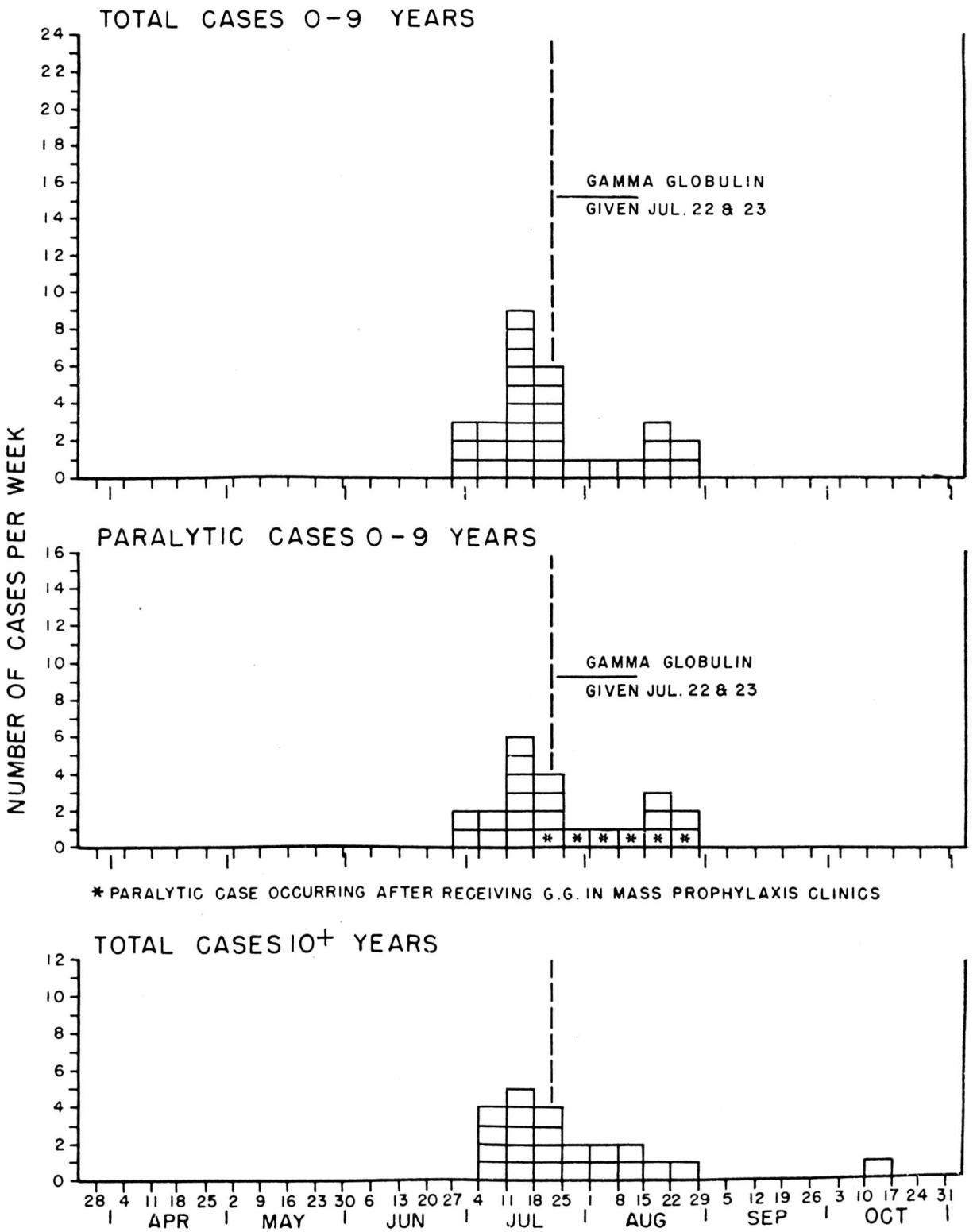


**Table 9. Number of cases and paralytic status by age group with onsets before and after the mass inoculation on July 22, Bristol, Va. and Tenn., Sullivan County, Tenn., exclusive of Bristol, and Washington County, Va.**

| Location | Number of cases and paralytic status | | | | | | | | | | | | Percent of total cases in each age group | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Before July 22 | | | | | | After July 22 | | | | | | Before July 22 | | After July 22 | |
| | 0–9 | | | 10+ | | | 0–9 | | | 10+ | | | 0–9 | 10+ | 0–9 | 10+ |
| | P | NP | Total | P | NP | Total | P | NP | Total | P | NP | Total | | | | |
| Bristol | 19 | 5 | 24 | 1 | 1 | 2 | 9 | 2 | 11 | 4 | 9 | 13 | 92. 3 | 7. 7 | 45. 8 | 54. 2 |
| Sullivan exclusive of Bristol | 5 | 2 | 7 | 2 | 2 | 4 | 8 | 3 | 11 | 4 | 3 | 7 | 63. 6 | 36. 4 | 61. 1 | 38. 9 |
| Washington | 13 | 5 | 18 | 7 | 4 | 11 | 6 | 3 | 9 | 8 | 5 | 13 | 62. 1 | 37. 9 | 40. 9 | 59. 1 |

P=paralytic. NP=nonparalytic.

day prior to the onset of the disease. Table 6 shows the interval between the dates of onset of the index case and of the subsequent cases. Table 7 summarizes the data on the subsequent cases.

*Cases Since Gamma Globulin Administration*

Since the mass inoculation program in Washington County and Bristol, Va., a total of 46 cases have occurred in these two areas. A list of the patients is presented in table 8. Of these cases, 14 received gamma globulin and 32 did not.

Table 9 shows the distribution of cases by age and paralytic status for each area before and after July 22, the day the community immunization clinics started. In Bristol, 7.7 percent of those attacked were over 9 years of age prior to this date; afterwards, the figure rose to 54.2 percent. In Washington County, Va., the same group represented 37.9 percent initially, which then rose to 59.1 percent. In Sullivan County, Tenn., where the number of cases was smaller, this shift cannot be demonstrated. There was no significant change in the ratio of paralytic to nonparalytic cases.

## Summary

An outbreak of poliomyelitis involving the two neighboring counties of Washington, Va., and Sullivan, Tenn., as well as the city of Bristol, Va. and Tenn., is described. The epidemic presented no particularly unusual features. Mass prophylaxis with gamma globulin was given to the children in Washington County and Bristol, Va., but no firm conclusions as to its efficacy can be drawn from the available data.

## Carter County, Tennessee

On July 23, 1953, Dr. Cecil Tucker, director of the division of preventable diseases of the Tennessee Department of Public Health, requested assistance from the Communicable Disease Center in the investigation of an outbreak of poliomyelitis in Carter County. Between April 1, 1953, and the date of the request, a total of 26 cases had been reported, giving an overall rate of 61 cases per 100,000 population (1950 census). Approximately 77 percent of the cases were said to be paralytic.

A team composed of Dr. Heinz F. Eichenwald, Epidemic Intelligence Service officer in charge, and Dr. Martin D. Keller, EIS officer, was assigned to Dr. Tucker. The team arrived in Elizabethton, Tenn., county seat of Carter County, on July 23, 1953, where they were assigned to Dr. James M. Willett, health officer of Carter County.

At this time Carter County had started a mass inoculation program with gamma globulin. From July 23 to July 25, the EIS officers participated in the mass inoculation program, after which they carried out a brief epidemiologic investigation. This was completed on July 28.

### Area and Poliomyelitis History

Carter County is in the northeastern portion of Tennessee in the mountains bordering North Carolina. The general economy is both industrial and agricultural. At least one member of most of the families residing in the county is employed in one of the two rayon mills located in Elizabethton. The main crops are tobacco and green beans, with increasing emphasis on cattle farming.

Many of the industrial workers live in rural areas and farm in their spare time and whenever the rayon mills close during the slack season. The total population, according to the 1950 census, was 42,432. Elizabethton accounted for 10,754 of this number. Since the 1940 census, the population had increased 21 percent. Less than 1 percent of the total number of residents is nonwhite.

The incidence of poliomyelitis in Carter County during the past 10 years has been low. Prior to this year, the greatest incidence occurred in 1948, when 10 cases were reported, a rate of 24 cases per 100,000 population. Only paralytic cases were reportable in Tennessee until 1953. These data are presented in table 1.

### Reporting, Diagnosis, and Hospitalization

Cases were reported by telephone directly to the county health officer, giving name, age, sex, race, address, and occasionally the type of involvement and the date of onset. On several occasions, the initial report was made by the hospital after the patient had been admitted. Following receipt of the report, a county public health nurse or the health officer visited the home of the patient and obtained information about the family contacts and sanitary conditions of the home.

About 70 percent of reported cases were hospitalized. All were admitted to the Johnson City Memorial Hospital, Johnson City, Tenn.

### Administration of Gamma Globulin

Gamma globulin was available to all household contacts up through age 19 and to pregnant women of any age. The material was dispensed by the health officer upon receipt of a requisition listing the name and address of the index case, plus the name, age, and address of all eligible contacts.

On July 17, 1953, the State department of

**Table 1. Number of reported cases of paralytic poliomyelitis, Carter County, Tenn., 1943–52**

| Year | Estimated population | Number of cases |
|---|---|---|
| 1943 | 37, 319 | 0 |
| 1944 | 38, 049 | 1 |
| 1945 | 38, 780 | 2 |
| 1946 | 39, 510 | 1 |
| 1947 | 40, 241 | 1 |
| 1948 | 40, 971 | 10 |
| 1949 | 41, 702 | 6 |
| 1950 | [1] 42, 432 | 8 |
| 1951 | 43, 163 | 1 |
| 1952 | 45, 354 | 5 |

[1] Census population.

Figure 1A. Total weekly poliomyelitis incidence rates per 100,000 population, Carter County, Tenn., 1953, by week of report, and paralytic status of cases, by week of onset.

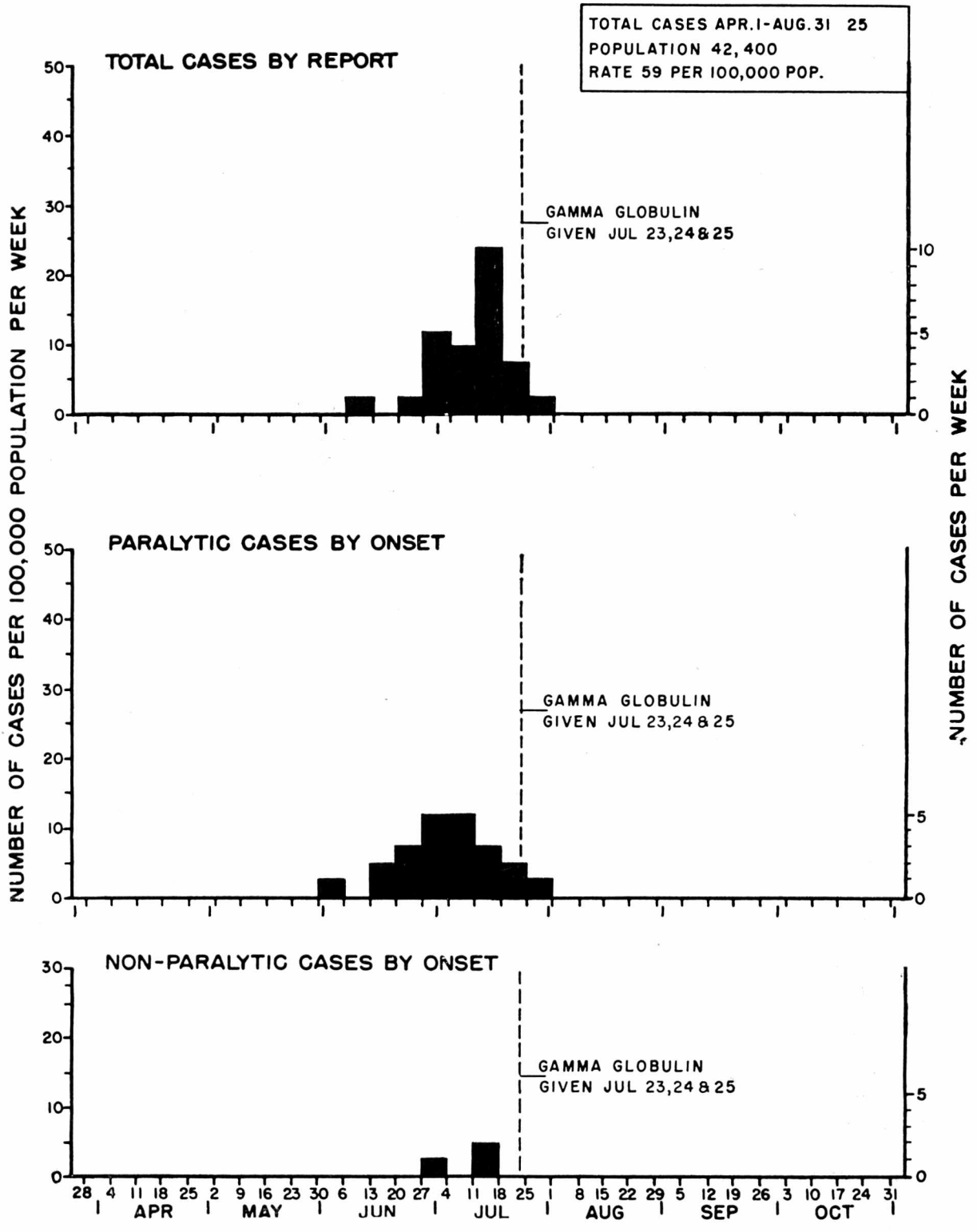


Figure 1B. Number of poliomyelitis cases per week, Carter County, Tenn., by week of onset, age group, and paralytic status.

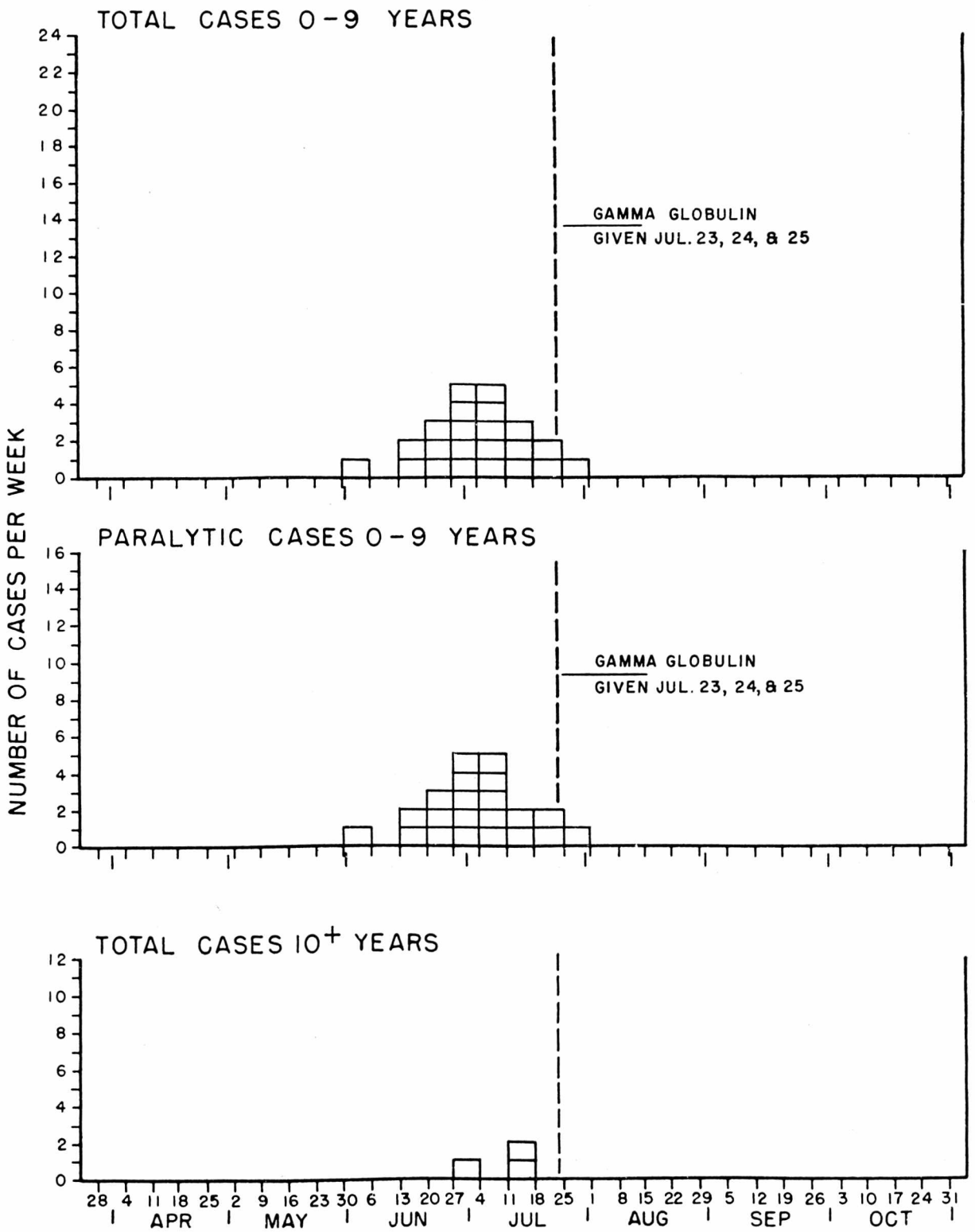


**Table 2. Distribution of total cases and paralytic cases of poliomyelitis, by week of onset and week of report, Carter County, Tenn., 1953**

| Week | Week of report | Week of onset | |
|---|---|---|---|
| | Total cases | Total cases | Paralytic cases |
| May 31–June 6 | 0 | 1 | 1 |
| June 7–13 | 1 | 0 | 0 |
| June 14–20 | 0 | 2 | 2 |
| June 21–27 | 1 | 3 | 3 |
| June 28–July 4 | 5 | 6 | 5 |
| July 5–11 | 4 | 5 | 5 |
| July 12–18 | 10 | 5 | 3 |
| July 19–25 | 3 | 2 | 2 |
| July 26–August 1 | 1 | 1 | 1 |
| Total | 25 | 25 | 22 |

public health requested gamma globulin for mass prophylaxis in Carter County. The request was denied at that time because the critical case level had not been reached. However, by July 19, enough cases had been reported for the county to qualify for gamma globulin.

From July 23 through July 25, gamma globulin was given to approximately 10,000 children within the age group of 6 months through 10 years.

## Epidemiologic Investigation

Between July 25 and July 28, the team collected information of general epidemiologic interest. Special emphasis was placed on the verification of diagnosis of type of involvement and dates of onset. In order to accomplish this, home visits were made, physicians and physical therapists were interviewed, and pertinent hospital records were checked. Of the 27 cases reported since April 1, 1953, the diagnosis of poliomyelitis was not confirmed on 2 patients.

### *Distribution of Cases in Time*

The outbreak began on June 5, when the first patient became ill. Thereafter, there were no cases until June 15, when two more patients had their onsets. The peak was reached during the week of June 28 to July 4, which was followed by a gradual decline during the following 4 weeks. The onset of the last case occurred on July 27, and no further confirmed cases

**Table 3. Distribution of total and paralytic cases of poliomyelitis, by age and rates per 100,000 population, Carter County and Elizabethton, Tenn., 1953**

| Age | Population (1950 census) | Total cases | Paralytic cases | Total rate per 100,000 population | Paralytic rate per 100,000 population |
|---|---|---|---|---|---|
| | Carter County, Tenn. | | | | |
| < 1 year | 935 | 0 | 0 | 0 | 0 |
| 1–4 years | 4, 350 | 12 | 12 | 276 | 276 |
| 5–9 years | 4, 859 | 10 | 9 | 206 | 185 |
| 10+ years | 32, 288 | 3 | 1 | 9. 3 | 3. 1 |
| Total, all ages | 42, 432 | 25 | 22 | 58. 9 | 51. 8 |
| | Elizabethton, Tenn. | | | | |
| < 1 year | 222 | 0 | 0 | 0 | 0 |
| 1–4 years | 979 | 4 | 4 | 409 | 409 |
| 5–9 years | 989 | 3 | 2 | 303 | 202 |
| 10+ years | 8, 564 | 3 | 1 | 35. 0 | 11. 7 |
| Total, all ages | 10, 754 | 10 | 7 | 93. 0 | 65. 1 |

Table 4. Attack rates per 100,000 population, by sex, for Carter County and for Elizabethton, Tenn., 1953

| Sex | Elizabethton | | | Remainder of Carter County | | | County total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Population | Total cases | Rate per 100,000 population | Population | Total cases | Rate per 100,000 population | Population | Total cases | Rate per 100,000 population |
| Male | 5, 132 | 4 | 77. 9 | 16, 042 | 10 | 62. 3 | 21, 174 | 14 | 66. 1 |
| Female | 5, 622 | 6 | 106. 7 | 15, 636 | 5 | 32. 0 | 21, 258 | 11 | 51. 7 |
| Total | 10, 754 | 10 | 93. 0 | 31, 678 | 15 | 47. 4 | 42, 432 | 25 | 58. 9 |

Table 5. Summary of subsequent cases in multiple-case households [1]

| Initials of patient | Age | Date of onset | Interval from index case to onset (days) | Interval, gamma globulin to onset (days) | Paralytic status |
|---|---|---|---|---|---|
| R. F | 3 | July 6 | 28 | 33 | Paralytic. |
| M. M | 5 | July 15 | 11 | 7 | Nonparalytic. |
| M. J. M | 13 | July 15 | 11 | 6 | Nonparalytic. |

[1] All subsequent cases had received gamma globulin.

have been reported from the county between then and August 31. These data are presented in table 2.

### *Distribution of Cases by Age, Sex, Race, and Residence*

There were no cases in the small nonwhite population. All patients were above 1 year of age, and the highest attack rate occurred in the 1–4 age group. The attack rate for males was higher than for females for the county as a whole, but the difference is not significant. These data are summarized in tables 3 and 4.

The attack rate for total cases in the county was 58.9 per 100,000. The rural-urban breakdown is shown in table 4. Elizabethton experienced an attack rate about twice that of the rural area.

### *Age Distribution Before and After Peak Week of Outbreak*

Before July 4, the date the epidemic reached its peak, 83 percent of the cases in the county were under 10 years of age. After July 4, 67 percent were under 10 years of age. If Elizabethton alone is considered, before July 4, 75 percent of the cases were under 10, and 67 percent after that date. In the rural areas these percentages are 87 percent and 67 percent, respectively.

### *Familial Aggregation*

There were 2 multiple-case households in Carter County. In one family, 2 cases occurred; in the other, 3 children became ill. All the subsequent cases had received gamma globulin. These data are summarized in table 5.

## Summary

An outbreak of poliomyelitis involving 25 cases in Carter County, Tenn., is described. Mass prophylaxis with gamma globulin was given late in the course of the epidemic. Only one case occurred after immunizations had been completed.

# Avery County, North Carolina

On July 29, 1953, Dr. Fred Foard, director of the division of epidemiology, North Carolina State Board of Health, requested the services of a team from the Communicable Disease Center to aid in the investigation of an outbreak of poliomyelitis in Caldwell, Catawba, and Avery Counties. The team, consisting of Dr. Heinz Eichenwald and Dr. Martin Keller, Epidemic Intelligence Service officers, and Harold W. Black, statistician, was under the direction of Dr. J. Graham Smith, EIS officer, assigned to the North Carolina State Board of Health. After the investigations in Caldwell and Catawba Counties had been completed, Drs. Smith and Keller reported to Dr. Cameron McRae, health officer of Avery County, on August 20.

At the time of their arrival in the county, 21 cases of poliomyelitis had been reported since April 1, 1953. All except one patient were reported as paralytic. There had been no deaths.

## Area and Poliomyelitis History

Avery County is in the northwestern portion of North Carolina. The terrain is generally hilly and the economy is chiefly agricultural. There are no large urban centers. The population has been stable during the past 10 years; the 1950 census listed 13,352 people, as compared to 13,561 in 1940. About 1.5 percent of the population is nonwhite.

Since 1940, Avery County has had a total of 33 reported cases of poliomyelitis. The peak year was in 1948, when 12 cases were reported, representing a rate of 89.6 per 100,000 population. The number of reported cases per year since 1940 is presented in table 1.

## Reporting, Diagnosis, and Hospitalization

Cases were reported by the attending physicians or hospital administrators by telephone to the county health officer, giving name, address, age, sex, race, date of onset and, if known, paralytic status. The final diagnosis was usually based on a report from the hospital. Sixty-seven percent of the total reported patients were hospitalized. Since the county has no hospital facilities, cases were sent to the following institutions: Asheville Orthopedic Hospital in Asheville, N. C.; Johnson City Memorial Hospital in Johnson City, Tenn.; and Grace Hospital in Banner Elk, N. C.

## Administration of Gamma Globulin

Gamma globulin was made available to household contacts under the age of 30 and to pregnant women in the household, regardless of age. The injections were generally given by the county health officer, but occasionally by the private physician. They were usually administered on the day of report or on the following day. A gamma globulin request form was signed by the physician, listing those in the household to receive the inoculations, their ages, weights, and the amount of gamma globulin to be used.

On August 6 and 7, a mass prophylaxis program was conducted in the county seat of Newland. Approximately 3,000 children received inoculations. The original age range was from birth

**Table 1. Number of reported cases of poliomyelitis and rates per 100,000 population, Avery County, N. C., 1940–52**

| Year | Estimated population | Number of cases | Attack rate |
|---|---|---|---|
| 1940 | [1] 13,561 | 1 | 7.4 |
| 1941 | 13,540 | 1 | 7.4 |
| 1942 | 13,519 | 0 | 0 |
| 1943 | 13,498 | 0 | 0 |
| 1944 | 13,477 | 8 | 59.4 |
| 1945 | 13,457 | 4 | 29.7 |
| 1946 | 13,436 | 0 | 0 |
| 1947 | 13,415 | 1 | 7.5 |
| 1948 | 13,394 | 12 | 89.6 |
| 1949 | 13,373 | 1 | 7.5 |
| 1950 | [1] 13,352 | 2 | 15.0 |
| 1951 | 13,331 | 2 | 15.0 |
| 1952 | 13,310 | 1 | 7.5 |

[1] Census population.

**Table 2. Distribution of total cases and of paralytic cases of poliomyelitis, by week of report and week of onset, Avery County, N. C., 1953**

| Week | Week of report | Week of onset | |
|---|---|---|---|
| | Total cases | Total cases | Paralytic cases |
| June 14–20 | 0 | 1 | 1 |
| June 21–27 | 0 | 0 | 0 |
| June 28–July 4 | 1 | 1 | 0 |
| July 5–11 | 1 | 1 | 1 |
| July 12–18 | 0 | 5 | 5 |
| July 19–25 | 5 | 2 | 2 |
| July 26–August 1 | 4 | 2 | 2 |
| Aug. 2–8 | 1 | 0 | 0 |
| Aug. 9–15 | 2 | 2 | 2 |
| Aug. 16–22 | 1 | 2 | 2 |
| Aug. 23–29 | 0 | 0 | 0 |
| Aug. 30–Sept. 5 | 3 | 2 | 2 |
| Sept. 6–12 | 0 | 0 | 0 |
| Sept. 13–19 | 1 | 1 | 1 |
| Total | 19 | 19 | 18 |

**Table 3. Number of total cases of poliomyelitis and rates per 100,000 population, by age, Avery County, N. C., 1953**

| Age | Population | Number of cases | Attack rate |
|---|---|---|---|
| < 1 year | 301 | 1 | 332 |
| 1–4 years | 1, 399 | 3 | 214 |
| 5–9 years | 1, 599 | [1] 7 | 438 |
| 10–14 years | 1, 596 | 2 | 125 |
| 15+ years | 8, 457 | 6 | 71 |
| Total, all ages | 13, 352 | 19 | 142 |

[1] Includes the 1 nonparalytic case.

to 10 years, but on the second day, older children were also included.

## Epidemiologic Investigation

From August 20 to August 22, when the team left Avery County, a household visit was made to every reported case of poliomyelitis and information for the completion of case investigation form 400.88A (appendix D) was obtained by personal interview of parents or other household members. Hospital information concerning the cases had been collected previously, when similar information had been obtained for the Caldwell and Catawba cases. Data on patients reported between August 23 and October 31, were collected by Dr. Smith.

A case was considered "suspect" if it was nonparalytic and no spinal puncture had been performed, or if there were less than 10 cells in the spinal fluid.

A total of 25 cases had been reported by October 31. Of these, 4 were classified as "suspect" and were excluded from the analysis. Two other patients were classified as "not polio." Of the proved cases, only one patient was nonparalytic. There were no deaths.

### *Distribution of Cases in Time*

The 19 proved cases of poliomyelitis occurred in Avery County between June 14 and September 14, a rate of 142 per 100,000 population. The distribution of cases by week of onset is presented in table 2. The first patient became ill the week of June 14. The next case occurred

**Table 4. Summary of subsequent cases in multiple-case households, Avery County, N. C., 1953**

| Household No. | Date of onset | Age | Interval from index case (days) | Paralytic status | Gamma globulin given |
|---|---|---|---|---|---|
| I | July 17 | 9 | 1 | Paralytic | No. |
| II | July 25 | 7 | 7 | ---do | No. |

**Table 5. Summary of cases with onset after mass inoculation of gamma globulin, August 6–7, Avery County, N. C., 1953**

| Case number | Age | Date of onset | Interval, gamma globulin to onset (days) | Paralytic status |
|---|---|---|---|---|
| | A. Those receiving gamma globulin | | | |
| 13 | 4 | Aug. 9 | 3 | P |
| 14 | 11 mo. | Aug. 12 | 6 | P |
| 17 | 3 | Aug. 21 | 15 | P |
| 18 | 1 | Sept. 1 | 24 | P |
| | B. Those not receiving gamma globulin | | | |
| 15 | 15 | Aug. 16 | ---------- | P |
| 16 | 14 | Aug. 21 | ---------- | P |
| 19 | 25 | Sept. 14 | ---------- | P |

Figure 1A. Total weekly poliomyelitis incidence rates per 100,000 population, Avery County, N. C., 1953, by week of report, and paralytic status of cases, by week of onset.

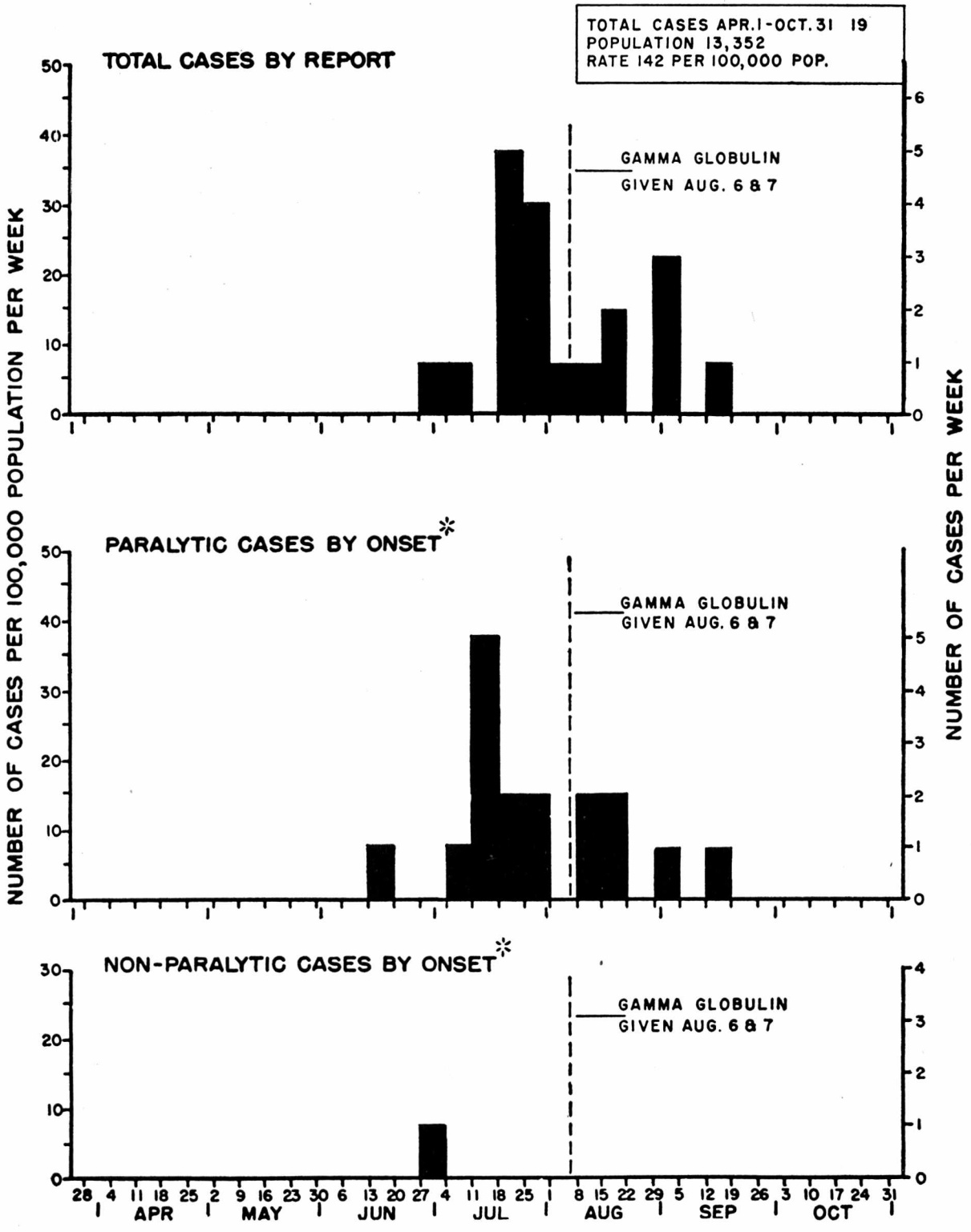
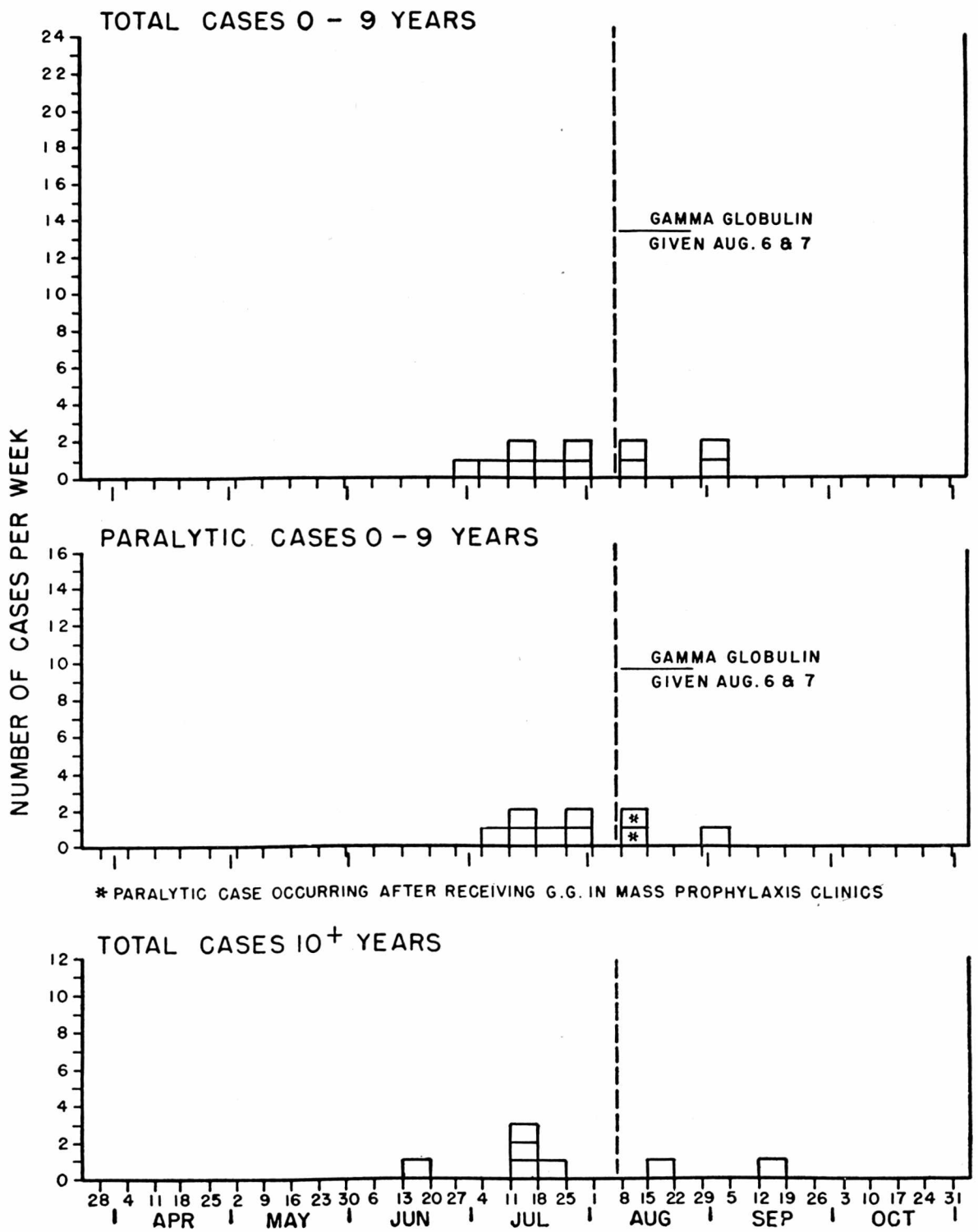


Figure 1B. Number of poliomyelitis cases per week, Avery County, N. C., 1953, by week of onset, age group, and paralytic status.



2 weeks later. During the week of July 12, 5 patients became ill; this marked the peak of the outbreak. The number of new cases then gradually subsided.

*Distribution of Cases by Race, Age, and Sex*

There were no cases among the small nonwhite population.

The age-specific attack rates are presented in table 3. The age group of 5–9 years had the highest attack rate, with a rate of 438 per 100,000 population. There were no significant differences in the sex-specific attack rates.

No significant change in the age distribution of cases occurred as the outbreak progressed.

*Familial Aggregation*

There were two proved multiple-case households in Avery County. There were two cases in both of these families. Table 4 summarizes these data.

*Cases Since Gamma Globulin Administration*

The mass inoculation program was conducted on August 6 and 7. Subsequent to this, 7 cases occurred. Four of these had received gamma globulin. All 7 cases were paralytic. These data are shown in table 5.

## Summary

An outbreak of poliomyelitis in a small rural county in North Carolina is described. Of the 19 proved cases, only 1 was nonparalytic. Gamma globulin mass prophylaxis was administered approximately 3 weeks after the peak of the epidemic had occurred. From the available data, it is not possible to draw any conclusions about the effect of mass prophylaxis on this outbreak.

# Smyth County, Virginia

On September 15, 1953, Dr. M. I. Shanholtz, commissioner of the Virginia Department of Health, invited the Communicable Disease Center to aid in the investigation of an outbreak of poliomyelitis in Smyth County, Virginia.

Dr. Martin Keller, Epidemic Intelligence Service officer, was assigned to Dr. Shanholtz, and through him to Dr. James Suter, acting director of health of the southwest district of Virginia. Dr. Keller reported to Dr. Suter in Abingdon on September 21.

Between April 1 and September 15, 50 cases of poliomyelitis had been reported in Smyth County, giving an attack rate of 166 cases per 100,000 population (1950 census). Eighteen, or 36 percent, of these patients were said to be paralytic. There had been no deaths. All except one of the reported patients had been hospitalized.

## Area and Poliomyelitis History

Smyth County is located in the southwestern portion of Virginia, midway between the Shenandoah Valley and the Great Smoky Mountains. It joins Washington County, another area of high poliomyelitis incidence, on the west. The terrain is generally hilly, the summer climate mild and dry. The economy is mainly agricultural. There are some industrial establishments located near the county seat of Marion. The population, according to the 1950 census, was 30,187, of which 1.6 percent were nonwhite. There had been a 4.6-percent increase over the 1940 population. Marion, the only urban center, had a population of 6,982, of which 3.7 percent were nonwhite.

Since 1940, the incidence of poliomyelitis has been generally low. The number of reported cases per year since 1940 is presented in table 1.

## Reporting, Diagnosis, and Hospitalization

Cases were reported by physicians, usually by telephone directly to the county health office, giving name, age, race, sex, address, date of onset, and paralytic status. All but one case were hospitalized either at the Crippled Children's and Memorial Hospitals, Roanoke, or the Johnston Memorial Hospital, Abingdon. At the request of the attending physician, doubtful cases were often visited by the district health officer to confirm the diagnosis. The final diagnosis of paralytic status was generally based on a report from the hospital.

## Administration of Gamma Globulin

Gamma globulin was made available to household contacts under the age of 20, and to pregnant women in the household, regardless of age. The injections were generally given by the private physician, but occasionally by the health officer. They were usually administered on the day of report or within a few days thereafter. A gamma globulin request form was submitted by the physician listing those in the household to receive the inoculation, their ages, and the amount of gamma globulin to be used.

On August 24, the county was authorized to conduct a mass prophylaxis program. This was carried out on August 26 and 27, and 6,546

**Table 1. Number and rate per 100,000 population of reported cases of poliomyelitis, Smyth County, Va., 1940–52**

| Year | Population | Number of cases | Number of cases per 100,000 population |
|---|---|---|---|
| 1940 | [1] 28, 861 | 2 | 6. 9 |
| 1941 | 28, 994 | 0 | 0 |
| 1942 | 29, 126 | 0 | 0 |
| 1943 | 29, 259 | 0 | 0 |
| 1944 | 29, 391 | 9 | 30. 6 |
| 1945 | 29, 524 | 0 | 0 |
| 1946 | 29, 657 | 1 | 3. 4 |
| 1947 | 29, 789 | 0 | 0 |
| 1948 | 29, 922 | 3 | 10. 0 |
| 1949 | 30, 054 | 2 | 6. 7 |
| 1950 | [1] 30, 187 | 21 | 69. 6 |
| 1951 | 30, 320 | 5 | 16. 5 |
| 1952 | 30, 452 | 15 | 49. 3 |

[1] Census population.

Figure 1A. Total weekly poliomyelitis incidence rates per 100,000 population, Smyth County, Va., 1953, by week of onset and paralytic status.

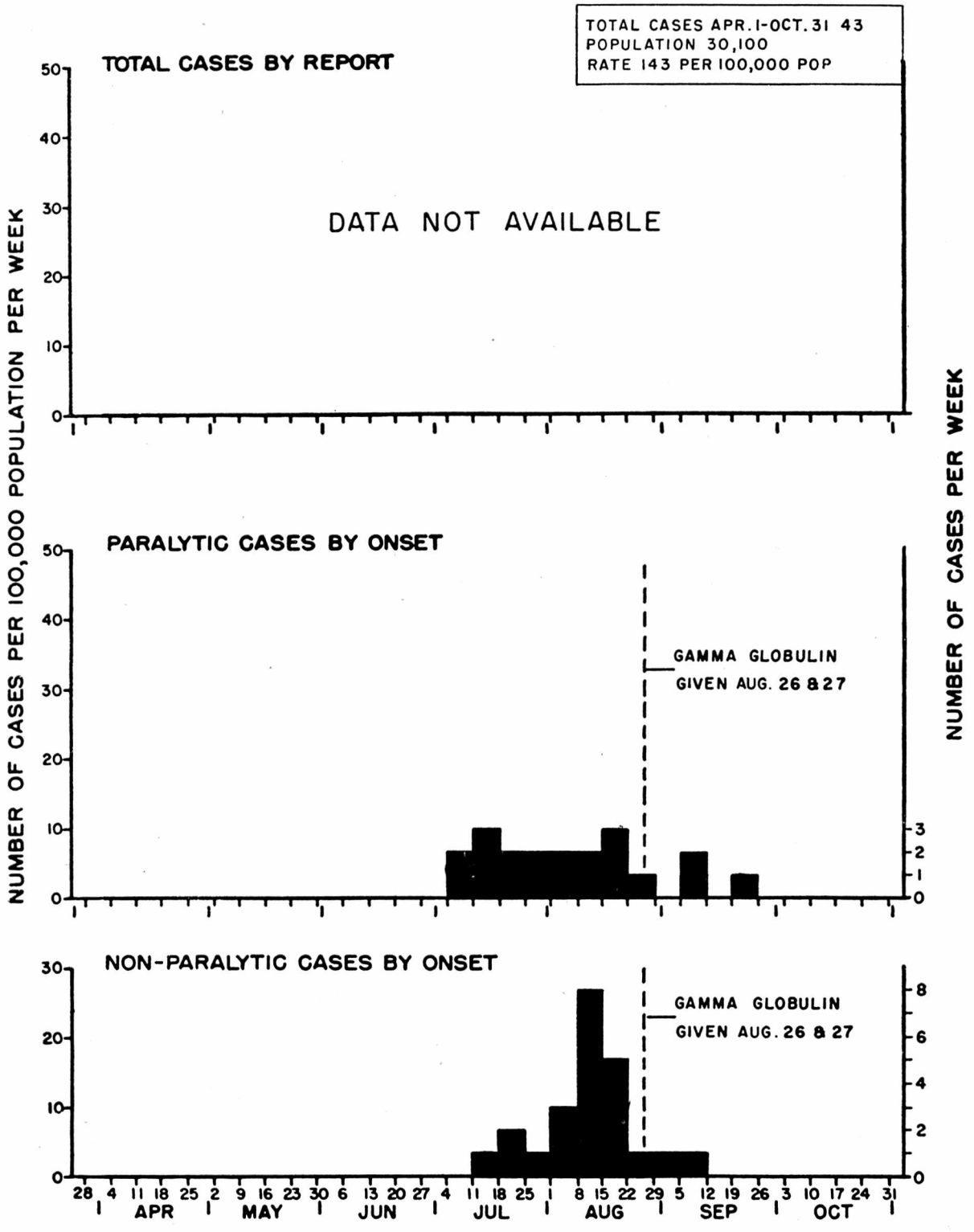


Figure 1B. Number of poliomyelitis cases per week, Smyth County, Va., 1953, by week of onset, age group, and paralytic status of cases.

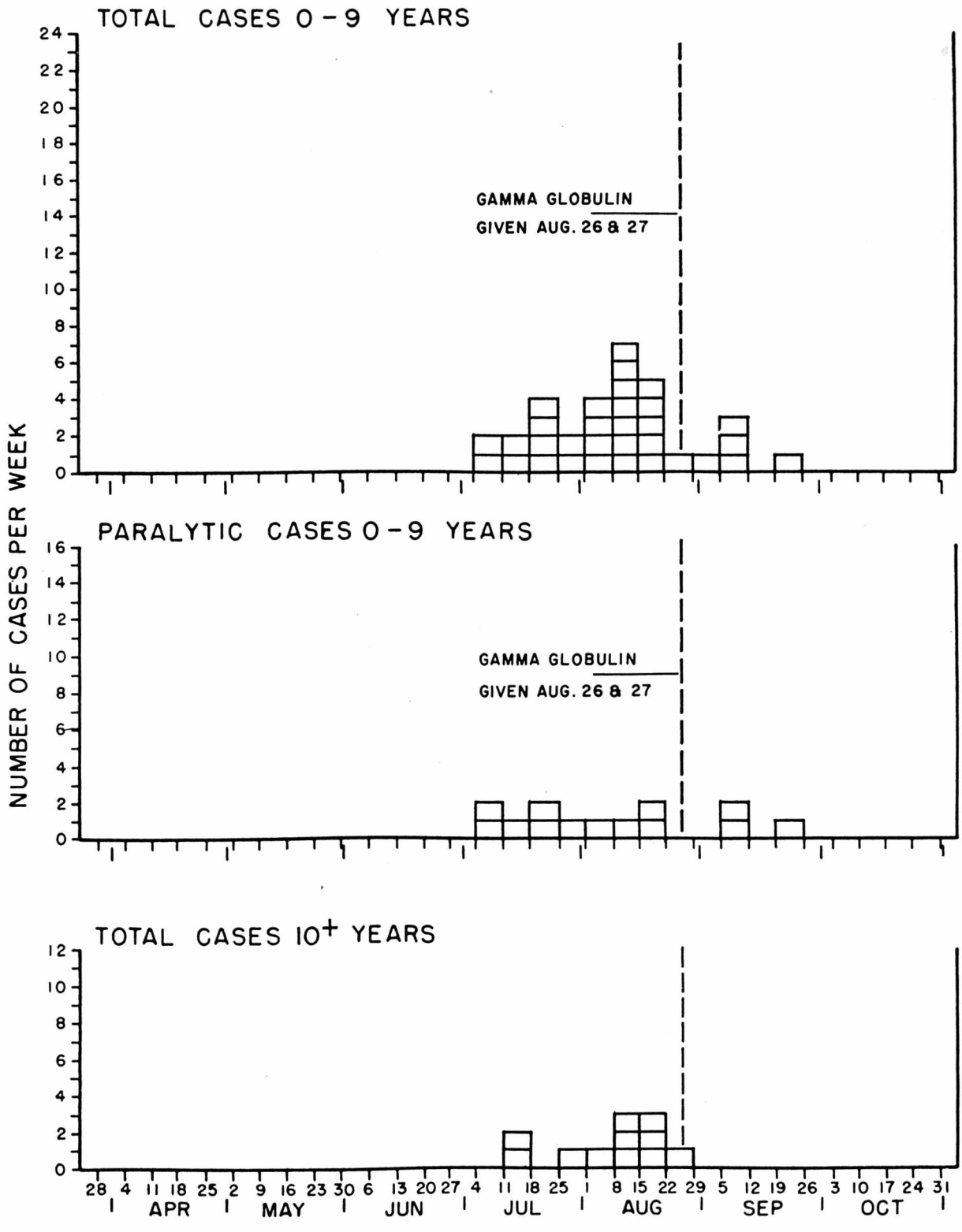


**Table 2. Distribution of total cases and of paralytic cases, by week of onset, Smyth County, Va., 1953**

| Week | Total cases | Paralytic cases |
|---|---|---|
| July 5–11 | 2 | 2 |
| July 12–18 | 4 | 3 |
| July 19–25 | 4 | 2 |
| July 26–Aug. 1 | 3 | 2 |
| Aug. 2–8 | 5 | 2 |
| Aug. 9–15 | 10 | 2 |
| Aug. 16–22 | 8 | 3 |
| Aug. 23–29 | 2 | 1 |
| Aug. 30–Sept. 5 | 1 | 0 |
| Sept. 6–12 | 3 | 1 |
| Sept. 13–19 | 0 | 0 |
| Sept. 20–26 | 1 | 1 |
| Total | 43 | 19 |

children, ranging in age from 6 months to 10 years, were inoculated in these 2 days.

## Epidemiologic Investigation

On September 22 and 23, general epidemiologic information about the reported cases was collected, special emphasis being placed on the verification of dates of onset and of the diagnosis of nonparalytic cases. Much of the data were obtained from the county health officer's records and from available hospital histories.

A total of 52 cases had been reported by October 31; 8 of these were classified as "suspect" cases and were excluded from the analysis. A case was considered "suspect" if it was nonparalytic and no spinal puncture had been performed, or less than 10 cells were found in the spinal fluid. The diagnosis of one additional case was changed to "brain tumor"; this was confirmed at autopsy. Of the 43 confirmed cases, 19, or 44 percent, were found to be paralytic. No deaths occurred due to poliomyelitis.

### *Distribution of Cases in Time*

The 43 confirmed cases of poliomyelitis occurred in Smyth County between July 9, 1953, and October 31, 1953.

The distribution of total and of paralytic cases by week of onset is presented in table 2. Data by week of report were not available. The first patient of the outbreak became ill during the week of July 5, and a progressive rise in cases began almost immediately. The peak was reached in the week of August 9, and thereafter the number of new cases subsided rapidly. Between September 10 and October 31, only 1 case of poliomyelitis occurred. Throughout the course of the outbreak, the weekly number of paralytic cases remained remarkably constant.

### *Distribution of Cases by Race, Age, Sex, and Residence*

There were no reported cases of poliomyelitis among the small nonwhite population. The age specific attack rates are presented in table 3. The highest rate, 547 per 100,000 population, occurred in children below 1 year of age, although the attack rates among children aged 1–9 years are not significantly less. The rate diminished after age 9, and was lowest in the population group 15 or more years of age.

Twelve cases occurred in the county seat of Marion, giving an attack rate of 171.8 per 100,000 population, as compared to a rate of 133.5 in the remainder of Smyth County. There were no significant differences in age specific attack rates between the rural and

**Table 3. Number and rate per 100,000 population of total and paralytic cases by age, Smyth County, Va.**

| Age group | Population (1950 Census) | Total number of cases | Number of paralytic cases | Total number of cases per 100,000 population | Number of paralytic cases per 100,000 population |
|---|---|---|---|---|---|
| < 1 year | 548 | 3 | 1 | 547 | 182 |
| 1–4 years | 2, 973 | 14 | 5 | 471 | 168 |
| 5–9 years | 3, 309 | 14 | 5 | 423 | 151 |
| 10–14 years | 3, 142 | 7 | 6 | 223 | 191 |
| 15+ years | 20, 215 | 5 | 2 | 24. 7 | 9. 9 |
| All ages | 30, 187 | 43 | 19 | 142. 4 | 62. 9 |

urban populations, nor were there any differences in rate between the two sexes. No evidence of radial spread could be detected.

**Table 4. Summary of all cases with onsets after the mass inoculation of gamma globulin on August 26 and 27, 1953, Smyth County, Va.**

| Initials of patient | Age | Date of onset | Paralytic status | Interval, gamma globulin to onset (days) |
|---|---|---|---|---|
| | A. Those receiving gamma globulin | | | |
| L. B. | 5 | Aug. 26 | Nonparalytic | 0 |
| B. B. | 5 | Aug. 31 | do | 5 |
| F. C. | 7 | Sept. 24 | do | 29 |
| | B. Those not receiving gamma globulin | | | |
| C. H. | 5 | Sept. 6 | Paralytic | |
| D. B. | 2 | Sept. 10 | Nonparalytic | |
| W. J. | 11 | Sept. 10 | Paralytic | |

*Familial Aggregation*

There were no confirmed multiple-case households in Smyth County. Of the households reported, both of the subsequent cases were listed as "suspect."

*Cases Since Gamma Globulin Administration*

The mass inoculation program was conducted on August 26 and 27. Subsequent to this, 6 cases occurred, 3 of whom had received gamma globulin. These data are summarized in table 4.

## Summary

An outbreak of poliomyelitis in Smyth County, Va., is briefly described. Except for the high attack rate in infants under 1 year of age, the outbreak presented no unusual features. Mass prophylaxis with gamma globulin was given several weeks after the peak of the epidemic had been reached.

# Stearns, Benton, and Meeker Counties, Minnesota

On September 8, 1953, Dr. A. J. Chesley, secretary and executive officer of the Minnesota Department of Health, stated that he would welcome assistance from the Communicable Disease Center in the investigation of an outbreak of poliomyelitis in Stearns and Benton Counties of central Minnesota. These counties had been approved for mass prophylaxis with gamma globulin on September 4, 1953, and the program was to be initiated on September 9, in Stearns County. At the time of the request, 106 cases had been reported in Stearns County and 19 in Benton County. Their populations (according to 1950 census) are 70,681 and 15,911, respectively. No deaths due to poliomyelitis had been reported from Stearns County at that time. Benton County had reported one fatality. The attack rates at this time for Stearns and Benton Counties were 150 and 119 per 100,000 population, respectively, based on 1950 census figures.

An adjacent county, Meeker County, was approved for mass prophylaxis on September 14, 1953. Twenty-two cases out of a population of 18,966 had been reported during this year, giving an attack rate of 160 per 100,000 population, based on the 1950 census figures.

The investigations were made by Dr. Ira L. Myers, Epidemic Intelligence Service officer, who worked under the direction of Dr. D. S. Fleming, director, division of disease prevention and control, and Dr. C. B. Nelson, chief, communicable disease section, Minnesota Department of Health. Locally, he was under the direction of Dr. J. P. O'Keefe, health officer, St. Cloud, Minn., the Stearns-Benton County Medical Society, and Dr. David D. Allison, health officer, Meeker County. Dr. Myers reported to Dr. R. N. Barr, deputy executive officer, Minnesota Department of Health, Minneapolis, in Dr. Chesley's absence from the city. The initial investigations were begun on September 9 and continued through September 25; the followup visits were completed November 9–14.

## Area and Poliomyelitis History

Stearns County is located in mid-central Minnesota on the Mississippi River. The terrain is rolling in character and the whole area contains numerous small lakes. This is chiefly an agricultural area with many small industries, a paper mill, and a large granite quarry. The population of Stearns County in 1950 was 70,681. The city of St. Cloud has a population of 22,781 and is located on the eastern border of the county on the Mississippi River. The city limits of St. Cloud encompass an area which extends into two adjacent counties, Benton to the northeast and Sherburne to the southeast. Approximately three-fifths of St. Cloud city is included in Stearns County. The population is almost entirely white (less than 0.2 percent is nonwhite), and the population has been quite stable during the past 10 years.

At least one large epidemic of poliomyelitis was investigated in Stearns County prior to 1920. In 1951, 32 cases were recorded. In 1952, 62 cases were recorded in Stearns County, 37 cases in Meeker County, and 16 cases in Benton County. The incidence of poliomyelitis in Stearns County during 1952 was considered to be unusually high. During this year, poliomyelitis cases were largely concentrated in the southern part of the State. During 1953, however, the incidence has been higher in the central and northern areas. This gives an impression of a northward progress of the disease during the last 2 years.

## Reporting, Diagnosis, and Hospitalization

Cases are reported through several channels in this area. A physician may report directly

to the State health officer or he may report to the city health officer. Reports may also be made by the physician through the hospital to the city nursing office, and from there to the health officer. The following information is usually included on the report: date, county, sanitary district, hospital, name, address of residence, age, sex, date of onset, type of involvement, and physician. About 97 percent of reported cases were hospitalized. In the past, the diagnosis was based on the physician's report and no further confirmatory measures were undertaken.

In many instances, a suspected case of poliomyelitis was taken to the local hospital for spinal fluid examination and then admitted immediately upon diagnosis. This was frequently true in St. Cloud. However, in some of the outlying villages with smaller hospitals, patients were frequently referred to one of the other hospitals in Minneapolis, which is about 68 to 80 miles to the southeast. Over 65 percent of the cases from Stearns and Benton Counties were hospitalized in the St. Cloud Hospital. About one-fifth of the cases from these counties and one-half from Meeker County were hospitalized in the Elizabeth Kenny Institute in Minneapolis, and the remainder were hospitalized in other hospitals either locally or in Minneapolis.

## Administration of Gamma Globulin

Gamma globulin in Minnesota is distributed through the State Department of Health in Minneapolis, and requests are usually received from the private physician by telephone. In most cases, a lag of from 1 to 2 days occurred between the request and the administration of gamma globulin in Stearns County, due to the fact that following receipt of the request, which specified the names, addresses, weights, and ages of contacts, the gamma globulin would be mailed to the physician. Gamma globulin was available to household contacts under age 30 and to pregnant women of the household, regardless of age. The injections were given by their private physicians.

On September 4, 1953, Stearns and the neighboring county of Benton were simultaneously approved for mass prophylaxis with gamma globulin. Meeker County was approved on September 14, 1953. These certifications were made on the basis of high attack rates accompanied by a rising incidence of reported cases.

The gamma globulin was available to all children in the three counties from age 6 months through 14 years. In Stearns County, the mass prophylaxis was given on September 9, 10, and 11. In Benton County, it was given on September 11, 14, and 15, and in Meeker County, on September 16, 17, and 18. In Stearns County and Benton County, 26,191 children were inoculated, and in Meeker County, 5,130.

## Epidemiologic Investigation

From September 9 through September 25, general epidemiologic information was obtained from all reported cases. Special emphasis was placed on the verification of the dates of onset and the confirmation of the diagnosis. An official list of all cases reported to the State Department of Health was secured from Dr. C. B. Nelson. This list was checked against the hospital records of the St. Cloud Hospital and the Elizabeth Kenny Institute, and was also cross-checked with the list of reported cases in the city nursing office in St. Cloud and again with the county nursing office in Stearns County. It became evident early in the investigations that home visits to all cases were not feasible due to the large area involved, difficulties in transportation, and difficulties in locating patients, a large number of whom resided in rural homes of three counties. Fortunately, the majority of cases were hospitalized and evaluations of physical therapists were available for the majority of cases in both St. Cloud Hospital and the Elizabeth Kenny Institute. Initially, the investigation included a review of pertinent hospital records, observations of hospitalized cases, and contacts with the private physician. Later, home contacts were possible and a better evaluation of the later cases was thus feasible.

In a number of instances, city and county nurses were most helpful in procuring information necessary for the completion of the detailed records. A followup visit was made to the three counties from November 9 through 14 to complete the original records and investigate cases which had occurred subsequent to the initial visit.

*Distribution of Cases in Time*

From February 1, 1953, to November 5, 1953, a total of 139 confirmed cases of poliomyelitis were reported from Stearns County; 99 of these were paralytic. In addition, 9 "suspect" cases were also reported. (For the purpose of this report, all reported cases of poliomyelitis that were nonparalytic or had either no spinal puncture or less than 10 cells in the spinal fluid, were classified as "suspect.")

From May 12, 1953, to October 5, 1953, 21 cases were reported in Benton County, 16 of these being classified as paralytic upon investigation. From January 30, 1953, to September 25, 1953, 21 cases were reported in Meeker County, 11 of which were classified as paralytic upon investigation. Three cases from Meeker County were reported as "suspect."

Thus, from the 3-county area, a total of 193 cases of poliomyelitis was reported to the State Department of Health; on investigation, 181 of these were confirmed cases of poliomyelitis and 12 were classified as suspect cases.

In only one case reported as poliomyelitis was the diagnosis changed. This case was one of encephalitis in a 17-year-old male from Meeker County, who was at first thought to have poliomyelitis, but after extensive study at the Elizabeth Kenny Institute and the University of Minnesota Hospitals, it was finally agreed that this was a case of "encephalitis of undetermined etiology."

Out of the total 139 confirmed cases in Stearns County, there were 4 deaths, 2 males, aged 12 and 43; and 2 females, aged 6 and 29. There was one death out of 21 confirmed cases in Benton County. This was a 47-year-old male. No deaths were noted in the 21 confirmed cases from Meeker County.

The peak week of the epidemic for the area was August 16 to 22. During this week, one fatality was observed in Stearns County, and the three other fatalities occurred within the ensuing 3 weeks. The case fatality rate for the area would therefore be 2.8 percent (based on all confirmed cases).

The incidence of poliomyelitis in this area showed a noteworthy increase during 1952, as indicated by tables 1–3. Consequently, as one might expect from this history and from the fact that many of the cases occurred late in the poliomyelitis season in 1952, cases continued to be reported in the area during the early

**Table 1. Number and rate of reported cases of poliomyelitis, Stearns County, Minn., 1946–53**

| Year | Population | Cases | Attack rate per 100,000 population |
|---|---|---|---|
| 1946 | 69, 289 | 59 | 85. 2 |
| 1947 | 69, 637 | 5 | 7. 2 |
| 1948 | 69, 985 | 29 | 41. 4 |
| 1949 | 70, 333 | 51 | 72. 5 |
| 1950 | 70, 681 | 11 | 15. 6 |
| 1951 | 71, 029 | 33 | 46. 5 |
| 1952 | 71, 377 | 62 | 86. 9 |
| 1953 | 71, 725 | [1] 139 | 193. 8 |

[1] Through December 1, 1953.

**Table 2. Number and rate of reported cases of poliomyelitis, Benton County, Minn., 1946–53**

| Year | Population | Cases | Attack rate per 100,000 population |
|---|---|---|---|
| 1946 | 15, 989 | 31 | 193. 9 |
| 1947 | 15, 970 | 1 | 6. 3 |
| 1948 | 15, 950 | 8 | 50. 2 |
| 1949 | 15, 931 | 9 | 56. 5 |
| 1950 | 15, 911 | 3 | 18. 9 |
| 1951 | 15, 892 | 9 | 56. 6 |
| 1952 | 15, 872 | 16 | 100. 8 |
| 1953 | 15, 853 | [1] 21 | 132. 3 |

[1] Through December 1, 1953.

**Table 3. Number and rate of reported cases of poliomyelitis, Meeker County, Minn., 1946–53**

| Year | Population | Number of cases | Attack rate per 100,000 population |
|---|---|---|---|
| 1946 | 19, 090 | 19 | 99. 5 |
| 1947 | 19, 059 | 4 | 21. 0 |
| 1948 | 19, 028 | 3 | 15. 8 |
| 1949 | 18, 997 | 28 | 147. 4 |
| 1950 | 18, 966 | 2 | 10. 5 |
| 1951 | 18, 935 | 1 | 5. 3 |
| 1952 | 18, 904 | 36 | 190. 4 |
| 1953 | 18, 873 | [1] 21 | 111. 3 |

[1] Through December 1, 1953.

months of 1953, as shown in table 4. However, the principal rise in cases was not noted until about the first of July. The last reported case for this area had its onset on November 5, 1953, and no further cases have been reported up to the first of December. Although there is some variation in the distribution of cases in time, in the three counties, the peak week of August 16 to 22 would apply essentially for the whole area.

Twenty-five percent of all confirmed cases in the area were classified as having bulbar involvement after investigation. Of the 126 confirmed paralytic cases, 45 were classified as bulbar.

*Distribution of Cases by Age, Sex, and Race*

No cases of poliomyelitis were reported in nonwhite persons, who comprise less than 0.2 percent of the total population in this area. The total poliomyelitis attack rate for the area is approximately 175 per 100,000 population. This rate may be broken down further to 108.3 and 167 cases per 100,000 population for males and females, respectively (tables 5–9). A total paralytic rate of about 118 per 100,000 population is observed, with a paralytic rate of 134 and 102 per 100,000 population being observed for males and females, respectively.

Of the paralytic cases, the highest attack rate was observed among males of ages 10 to 14, where a rate of almost 509 per 100,000 population was noted. The white females in this same age group experienced only 296 cases of poliomyelitis per 100,000 population. The peak rate of paralytic cases among the females was observed in the age group 5–9 years. The attack rates at these peak ages were over 3½ times that of the total attack rate for each of the sexes (table 9).

**Table 4. Distribution of total cases and paralytic cases of poliomyelitis, by weeks of onset, Stearns, Benton, and Meeker Counties, Minn., 1953**

| Week | Stearns County | | Benton County | | Meeker County | |
|---|---|---|---|---|---|---|
| | Total cases | Paralytic cases | Total cases | Paralytic cases | Total cases | Paralytic cases |
| *1953* | | | | | | |
| Jan. 25–31 | 0 | 0 | 0 | 0 | 1 | 0 |
| Feb. 1–7 | 2 | 1 | 0 | 0 | 0 | 0 |
| Feb. 8–14 | 1 | 1 | 0 | 0 | 0 | 0 |
| May 3–9 | 1 | 1 | 0 | 0 | 0 | 0 |
| May 10–16 | 0 | 0 | 1 | 1 | 0 | 0 |
| May 17–23 | 0 | 0 | 1 | 1 | 0 | 0 |
| June 7–13 | 1 | 1 | 2 | 2 | 0 | 0 |
| June 14–20 | 0 | 0 | 1 | 1 | 0 | 0 |
| June 21–27 | 0 | 0 | 0 | 0 | 1 | 1 |
| June 28–July 4 | 2 | 2 | 1 | 1 | 1 | 1 |
| July 5–11 | 3 | 2 | 0 | 0 | 0 | 0 |
| July 12–18 | 8 | 6 | 2 | 2 | 1 | 0 |
| July 19–25 | 6 | 5 | 1 | 1 | 0 | 0 |
| July 26–Aug. 1 | 13 | 11 | 1 | 1 | 0 | 0 |
| Aug. 2–8 | 14 | 10 | 1 | 0 | 0 | 0 |
| Aug. 9–15 | 9 | 7 | 3 | 1 | 2 | 2 |
| Aug. 16–22 | 23 | 15 | 0 | 0 | 6 | 2 |
| Aug. 23–29 | 11 | 9 | 4 | 3 | 3 | 3 |
| Aug. 30–Sept. 5 | 11 | 7 | 1 | 1 | 4 | 2 |
| Sept. 5–12 | 17 | 12 | 1 | 1 | 1 | 0 |
| Sept. 13–19 | 11 | 5 | 0 | 0 | 0 | 0 |
| Sept. 20–26 | 2 | 1 | 0 | 0 | 1 | 0 |
| Sept. 27–Oct. 3 | 1 | 1 | 0 | 0 | 0 | 0 |
| Oct. 4–10 | 0 | 0 | 1 | 0 | 0 | 0 |
| Oct. 11–17 | 0 | 0 | 0 | 0 | 0 | 0 |
| Oct. 18–24 | 1 | 1 | 0 | 0 | 0 | 0 |
| Oct. 25–31 | 1 | 0 | 0 | 0 | 0 | 0 |
| Nov. 1–7 | 1 | 1 | 0 | 0 | 0 | 0 |
| Nov. 8–14 | 0 | 0 | 0 | 0 | 0 | 0 |
| Totals | 139 | 99 | 21 | 16 | 21 | 11 |



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From tables 1–3, it is apparent that the highest attack rate, 194 per 100,000 population, occurred in Stearns County; Benton was second with 132; and Meeker followed with 111. However, Meeker County had observed a rate of 190 per 100,000 population the year before, while Stearns County had observed only 87 per 100,000 population the same year.

*Family Aggregations*

In the study area, there were eight multiple case households, all consisting of only two cases. Six of these multiple-case households occurred in Stearns County and one each were observed in Meeker and Benton Counties. In table 10, a summary of the interval of time between the onset of the first and subsequent cases in

**Table 5. Attack rates of poliomyelitis per 100,000 population, by sex (total reported confirmed cases), Stearns Benton, and Meeker Counties, Minn., 1953**

| Sex | Stearns County | | | Benton County | | | Meeker County | | |
|---|---|---|---|---|---|---|---|---|---|
| | Population | Cases | Rate | Population | Cases | Rate | Population | Cases | Rate |
| Male | 36, 540 | 72 | 197. 0 | 8, 263 | 13 | 157. 3 | 9, 859 | 13 | 131. 9 |
| Female | 34, 141 | 67 | 196. 3 | 7, 648 | 8 | 104. 6 | 9, 107 | 8 | 87. 8 |
| Total | 70, 681 | 139 | 196. 7 | 15, 911 | 21 | 132 | 18, 966 | 21 | 107. 2 |

**Table 6. Number of cases and rates of poliomyelitis, by age groups, sex, and paralytic status, Stearns County, Minn., 1953**

| Age group | Population | | Paralytic cases | | | | Total cases | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Male | | Female | | Male | | Female | |
| | | | Number | Rate | Number | Rate | Number | Rate | Number | Rate |
| <1 year | 898 | 883 | 1 | 111. 4 | 0 | 0 | 1 | 111. 4 | 0 | 0 |
| 1–4 years | 3, 484 | 3, 329 | 9 | 258. 3 | 6 | 180. 2 | 13 | 373. 1 | 10 | 300. 4 |
| 5–9 years | 3, 559 | 3, 362 | 15 | 421. 5 | 16 | 475. 9 | 18 | 505. 8 | 24 | 713. 9 |
| 10–14 years | 3, 225 | 3, 150 | 21 | 651. 2 | 12 | 381. 0 | 25 | 775. 2 | 16 | 507. 9 |
| 15+ years | 25, 374 | 23, 417 | 10 | 39. 4 | 9 | 38. 4 | 15 | 59. 1 | 17 | 72. 6 |
| Total | 36, 540 | 34, 141 | 56 | 153. 3 | 43 | 125. 9 | 72 | 197. 0 | 67 | 196. 2 |

**Table 7. Number of cases and rates of poliomyelitis, by age group, sex, and paralytic status, Benton County, Minn., 1953**

| Age group | Population | | Paralytic cases | | | | Total cases | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Male | | Female | | Male | | Female | |
| | | | Number | Rate | Number | Rate | Number | Rate | Number | Rate |
| <1 year | 208 | 211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1–4 years | 905 | 812 | 3 | 331. 4 | 2 | 246. 3 | 5 | 552. 5 | 2 | 246. 3 |
| 5–9 years | 831 | 810 | 4 | 481. 4 | 1 | 123. 5 | 5 | 601. 7 | 1 | 123. 5 |
| 10–14 years | 780 | 755 | 1 | 128. 2 | 1 | 132. 5 | 1 | 128. 2 | 1 | 132. 5 |
| 15+ years | 5, 539 | 5, 060 | 2 | 36. 1 | 2 | 39. 5 | 2 | 36. 1 | 4 | 79. 1 |
| Total | 8, 263 | 7, 648 | 10 | 121. 0 | 6 | 78. 5 | 13 | 157. 3 | 8 | 104. 6 |

multiple-case households is presented. Table 11 summarizes the time interval between the index cases and subsequent cases and their paralytic status. The numbers here are too small to attempt significant conclusions.

*Cases Since Gamma Globulin Administration*

Since the mass inoculation program in this area, there have been 24 cases reported who had onsets subsequent to the mass inoculation program in their respective area. This information is summarized in table 12. It will be observed that only one case occurred in Meeker County subsequent to the inoculation program, and this one was classified as a nonparalytic case who developed poliomyelitis about 9 days after gamma globulin was administered. In Stearns County, there were 11 subsequent cases who received gamma globulin and 10 subsequent cases who did not receive gamma globulin. However, if one looks at the ages, it will be observed that the number not receiving gamma globulin is heavily weighted in favor of the older age group. Of those in Stearns County who did not receive gamma globulin, five were classified as paralytic and five as nonparalytic. Of those who did receive gamma globulin, seven were classified as paralytic and four as nonparalytic. This information should be considered as only one small part of the mass of information necessary to make any sort of an evaluation. The age distribution as well as the interval of time between administration of gamma globulin and the onset of poliomyelitis causes many questions to arise in the comparison of these two groups (which is not practical on these small numbers).

It will be observed that the administration of gamma globulin was effected in the area about 3 weeks after the apparent peak week. In an effort to evaluate the use of

**Table 8. Number of cases and rates of poliomyelitis, by age group, sex, and paralytic status, Meeker County, Minn., 1953**

| Age group | Population | | Paralytic cases | | | | Total cases | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Male | | Female | | Male | | Female | |
| | | | Number | Rate | Number | Rate | Number | Rate | Number | Rate |
| <1 year | 222 | 206 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1–4 years | 857 | 855 | 1 | 116. 7 | 0 | 0 | 2 | 233. 4 | 0 | 0 |
| 5–9 years | 908 | 912 | 0 | 0 | 1 | 109. 7 | 2 | 220. 3 | 2 | 219. 3 |
| 10–14 years | 912 | 824 | 3 | 328. 9 | 0 | 0 | 4 | 438. 6 | 4 | 485. 4 |
| 15+ years | 6, 960 | 6, 310 | 4 | 57. 5 | 1 | 15. 9 | 6 | 86. 2 | 1 | 15. 9 |
| Total | 9, 859 | 9, 107 | 8 | 81. 1 | 2 | 22 | 14 | 142 | 7 | 76. 9 |

**Table 9. Cases and rates of poliomyelitis, by age groups, sex, and paralytic status, in three-county prophylaxis area (Stearns, Benton, and Meeker Counties, Minn.), 1953**

| Age group | Population | | Paralytic cases | | | | Total cases | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Male | | Female | | Male | | Female | |
| | | | Number | Rate | Number | Rate | Number | Rate | Number | Rate |
| <1 year | 1, 328 | 1, 300 | 1 | 75. 3 | 0 | 0 | 1 | 75. 3 | 0 | 0 |
| 1–4 years | 5, 249 | 4, 996 | 13 | 247. 6 | 8 | 160. 1 | 20 | 381. 0 | 12 | 240. 2 |
| 5–9 years | 5, 298 | 5, 084 | 19 | 358. 6 | 18 | 354. 1 | 25 | 471. 9 | 27 | 531. 1 |
| 10–14 years | 4, 917 | 4, 729 | 25 | 508. 4 | 14 | 296. 1 | 31 | 630. 5 | 24 | 507. 5 |
| 15+ years | 37, 873 | 34, 787 | 15 | 39. 6 | 12 | 34. 5 | 23 | 60. 7 | 22 | 63. 2 |
| Total | 54, 665 | 50, 896 | 73 | 133. 5 | 52 | 102. 2 | 100 | 182. 9 | 85 | 167. 0 |

**Table 10. Interval of days between onset of first and subsequent cases in multiple-case households, Stearns, Benton, and Meeker Counties, Minn., 1953**

| Interval (days) | Total cases | Paralytic cases |
|---|---|---|
| 0 | 0 | 0 |
| 1 | 0 | 0 |
| 2 | 2 | 1 |
| 3 | 0 | 0 |
| 4 | 0 | 0 |
| 5 | 0 | 0 |
| 6 | 2 | 2 |
| 7 | 1 | 1 |
| 8 | 0 | 0 |
| 9 | 0 | 0 |
| 10 | 0 | 0 |
| 11 | 1 | 0 |
| 12 | 0 | 0 |
| 13 | 1 | 0 |
| 14 | 0 | 0 |
| 15 | 0 | 0 |
| 16 | 0 | 0 |
| 17 | 1 | 1 |
| Total | 8 | 5 |

gamma globulin and its effect in the area, a program was outlined on the first visit. Miss Alice Chesrown, the physical therapist trained in the standardized muscle evaluation, is responsible in Minnesota for the muscle-testing of multiple-case household cases. Arrangements were made through Dr. Richard Johnson of the Minnesota State Crippled Children's Services for Miss Chesrown to perform the 50–70 day muscle evaluation tests on all cases under 15 years of age who were found to have onsets from September 3 through November 15. Through this method, two groups of cases would be studied. One group consists of patients with onsets in the week prior to the initiation of the program, and would not have received gamma globulin. The other group would include those with onsets after mass prophylaxis, and therefore had received gamma globulin prior to their onsets. Thus, the severity of cases occurring immediately before the mass prophylaxis could be compared with the severity of those coming down after re-receiving gamma globulin. It was hoped that these data would be added to comparable data from other epidemic areas and evaluated as part of the National Gamma Globulin Evaluation Program. The last few muscle tests for the area were scheduled to be completed by Miss Chesrown on December 21, 1953. The 7–14 day confirmation of diagnoses has already been completed by the epidemiologist, and the majority of the muscle tests in the 60–70 day evaluation have been received and attached to the original records for later use as specified.

Although the result of the investigation of poliomyelitis in this area cannot be conclusive within itself, it does offer valuable data for use

**Table 11. Summary of subsequent cases in multiple-case households, Stearns, Benton, and Meeker Counties, Minn., 1953**

| Initials of patient | Date of onset | Interval from index case to onset (days) | Date gamma globulin administered | Paralytic status |
|---|---|---|---|---|
| A. Those receiving gamma globulin | | | | |
| R. D. R.[1] | July 31 | 2 | Aug. 1 | Not paralyzed. |
| R. J. M.[1] | Aug. 4 | 6 | Aug. 2 | Paralyzed. |
| M. I. K.[1] | Aug. 19 | 7 | Aug. 17 | Do. |
| G. L.[2] | Aug. 26 | 13 | Aug. 21 | Not paralyzed. |
| C. J.[3] | Sept. 2 | 11 | Sept. 4 | Do. |
| B. Those not receiving gamma globulin | | | | |
| P. T. N.[1] | July 30 | 17 | | Paralyzed. |
| K. J. M.[1] | Aug. 1 | 2 | | Do. |
| R. M. B.[1] | Aug. 7 | 6 | | Do. |

[1] Stearns County. [2] Benton County. [3] Meeker County.

**Table 12. Summary of all cases with onsets after the mass inoculation of gamma globulin on September 9–11, Stearns County; September 11–15, Benton County; and on September 16–18, Meeker County. (Exclusive of multiple-case household cases)**

| County | Initials of patient | Age | Date of onset | Paralytic status | Interval, gamma globulin to onset (days) |
|---|---|---|---|---|---|
| | A. Those receiving gamma globulin | | | | |
| Stearns | M. A. S. | 5 | Sept. 13 | P | 2 |
| Do | K. L. K. | 11 | ___do___ | P | 2 |
| Do | M. L. | 3 | Sept. 14 | NP | 2 |
| Do | C. R. | 11 | ___do___ | P | 3 |
| Do | M. B. | 5 | Sept. 15 | P | 6 |
| Do | N. P. | 12 | Sept. 16 | P | 5 |
| Do | T. R. C. | 11 | Sept. 17 | NP | 8 |
| Do | T. E. J. | 9 | Sept. 18 | NP | 7 |
| Do | C. C. Z. | 8 | Sept. 20 | P | 10 |
| Do | T. B. | 6 | Oct. 24 | P | 46 |
| Do | L. M. R. | 9 | Oct. 28 | NP | 50 |
| Benton | L. K. B. | 4 | Sept. 12 | P | 3 |
| Do | M. R. J. | 3 | Oct. 5 | NP | Unknown |
| Meeker | J. D. | 5 | Sept. 25 | NP | 9 |
| | B. Those not receiving gamma globulin | | | | |
| Stearns | I. B. R. | 16 | Sept. 9 | P | ---------- |
| Do | D. K. | 29 | ___do___ | P (fatal) Sept. 13 | ---------- |
| Do | M. D. R. | 8 | Sept. 10 | NP | ---------- |
| Do | J. M. R. | 16 | ___do___ | P | ---------- |
| Do | E. J. O. | 24 | Sept. 13 | NP | ---------- |
| Do | L. D. | 23 | Sept. 17 | NP | ---------- |
| Do | D. F. G. | 19 | Sept. 18 | NP | ---------- |
| Do | M. F. | 29 | Sept. 20 | NP | ---------- |
| Do | L. R. | 23 | Sept. 28 | P | ---------- |
| Do | D. M. | 8 months | Nov. 6 | P | ---------- |

P=paralytic. NP=nonparalytic.

in appraising the effectiveness of gamma globulin in modifying the severity of poliomyelitis cases studied in the National Program.

## Summary

An outbreak of poliomyelitis involving Stearns, Benton, and Meeker Counties, Minn., is described. A total of 193 confirmed cases occurred between February 1 and November 5. Mass prophylaxis with gamma globulin was administered in all three counties. From the available data, no conclusions concerning the effect of gamma globulin on the course of the epidemic can be drawn.

Figure 1A. Total weekly poliomyelitis incidence rates per 100,000 population, Stearns County, Minn., 1953, by week of report, and paralytic status of cases, by week of onset.

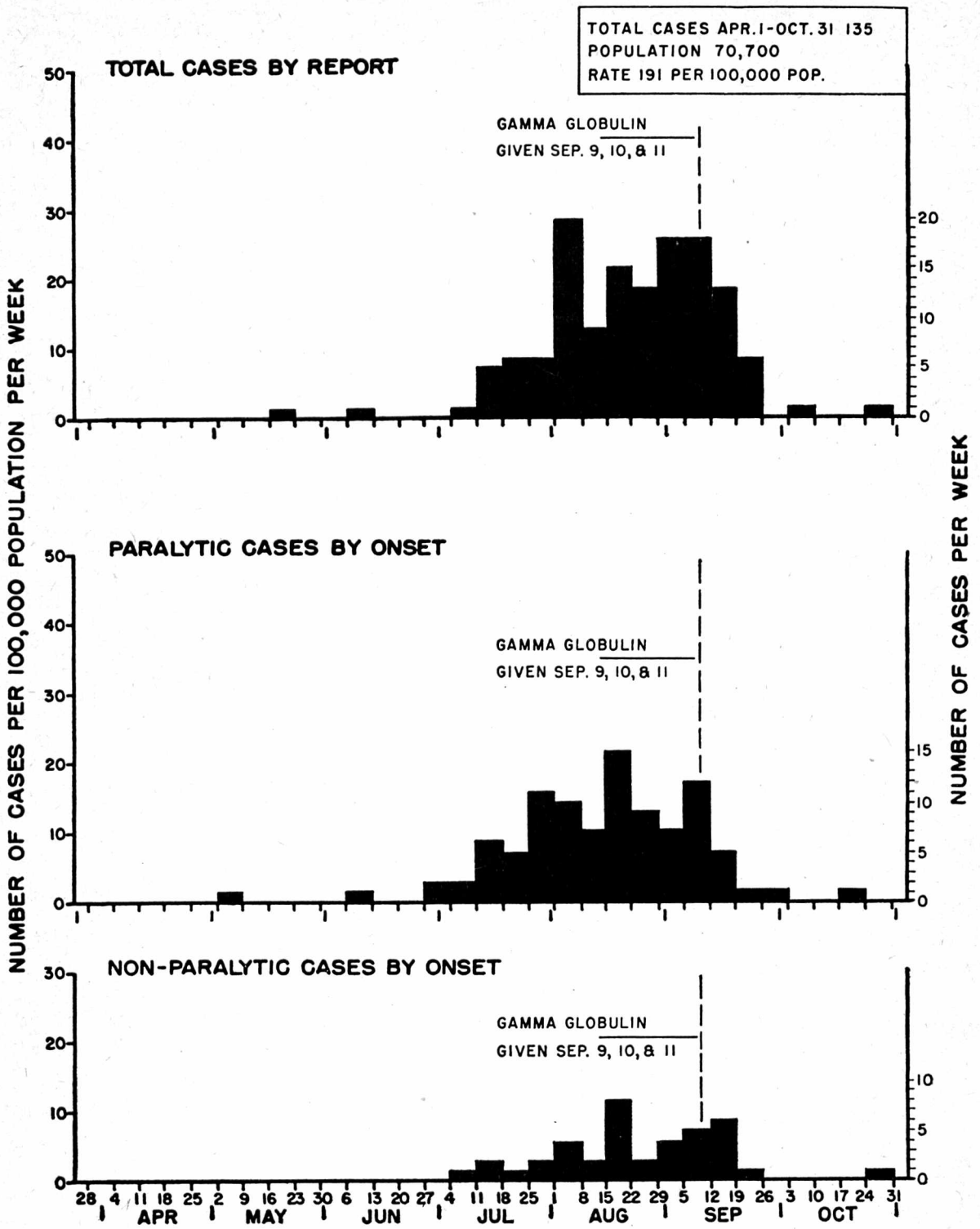


Figure 1B. Number of poliomyelitis cases per week, Stearns County, Minn., 1953, by week of onset, age group, and paralytic status.

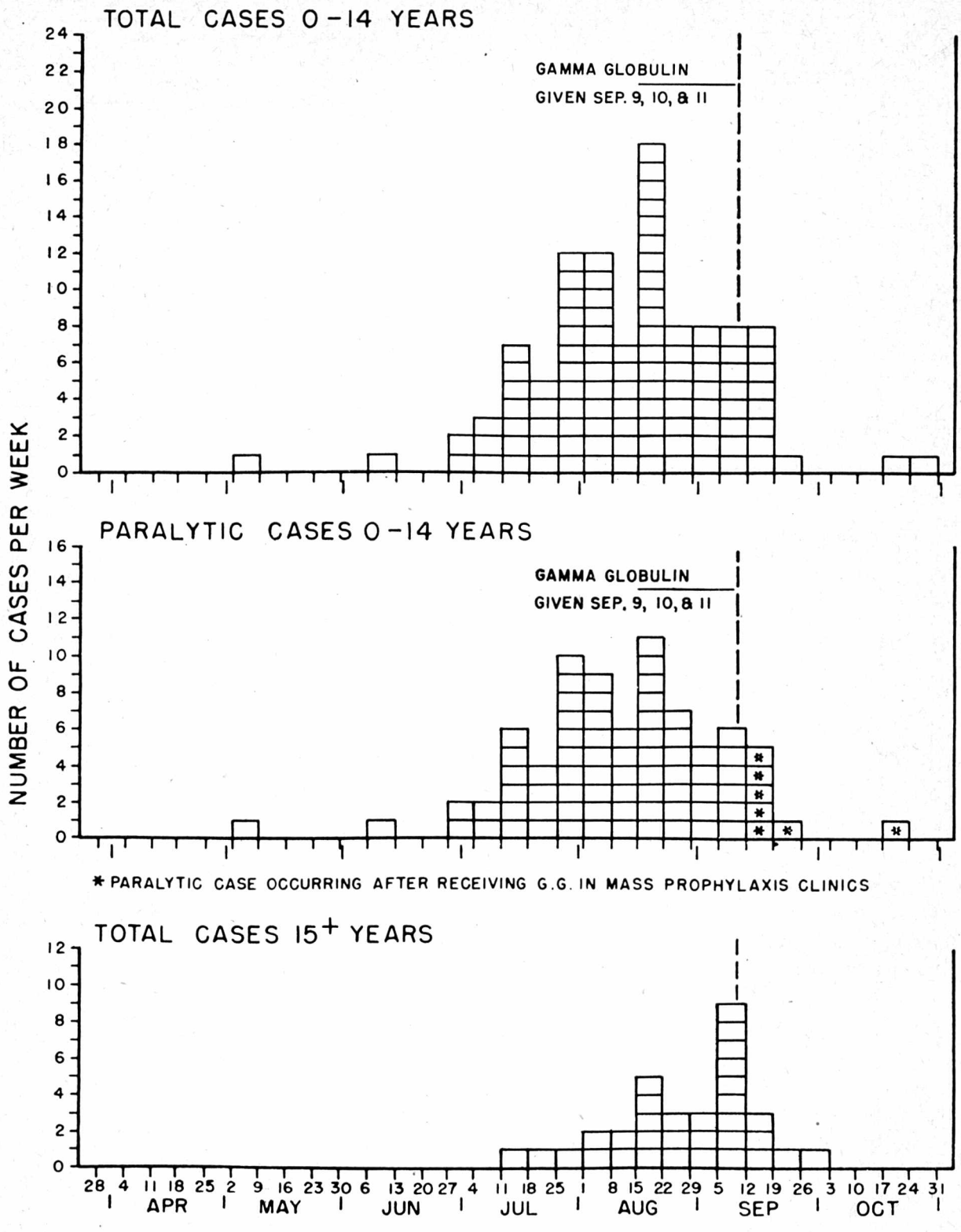


Figure 2A. Total weekly poliomyelitis incidence rates per 100,000 population, Benton County, Minn., 1953, by week of report, and paralytic status of cases, by week of onset.

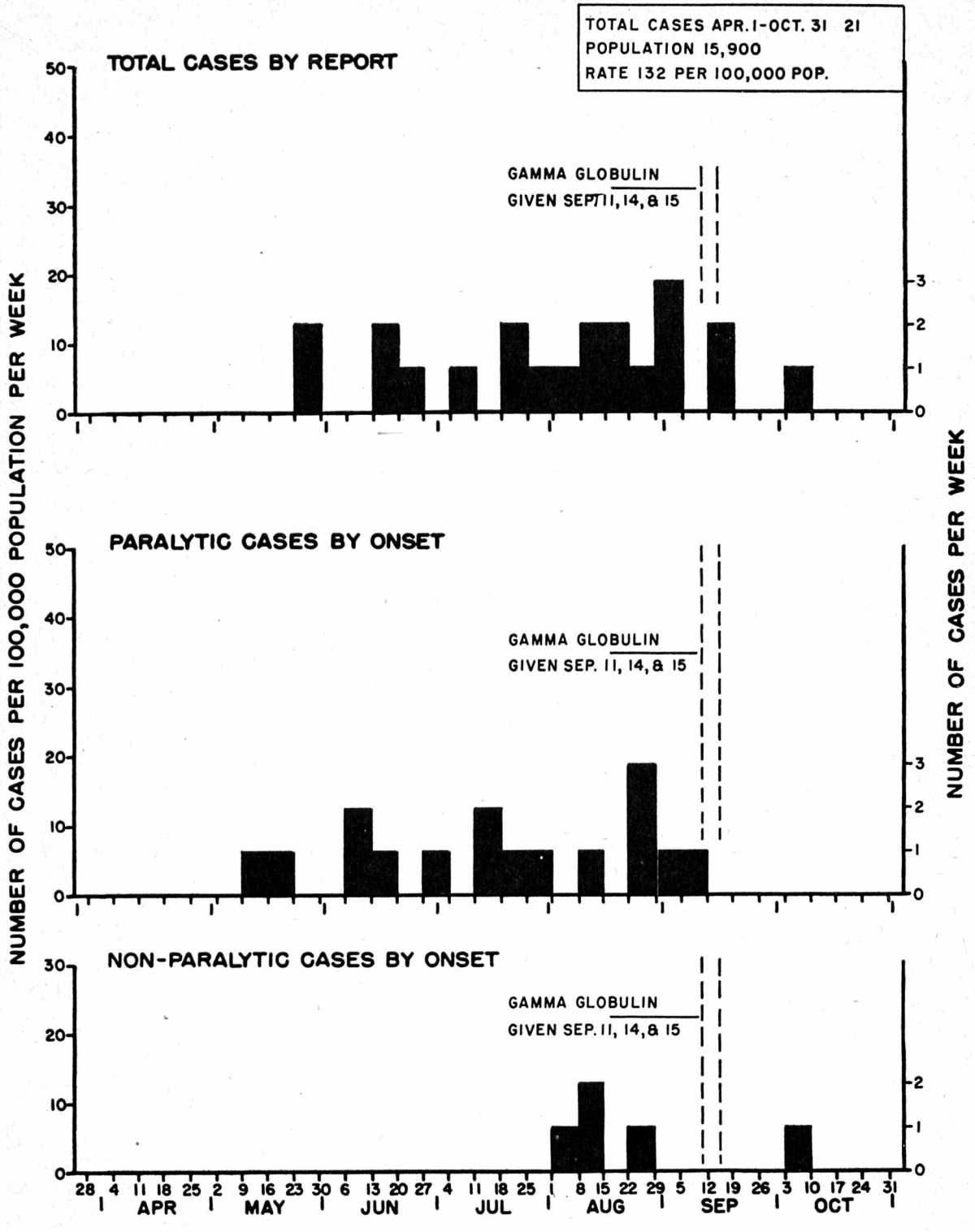
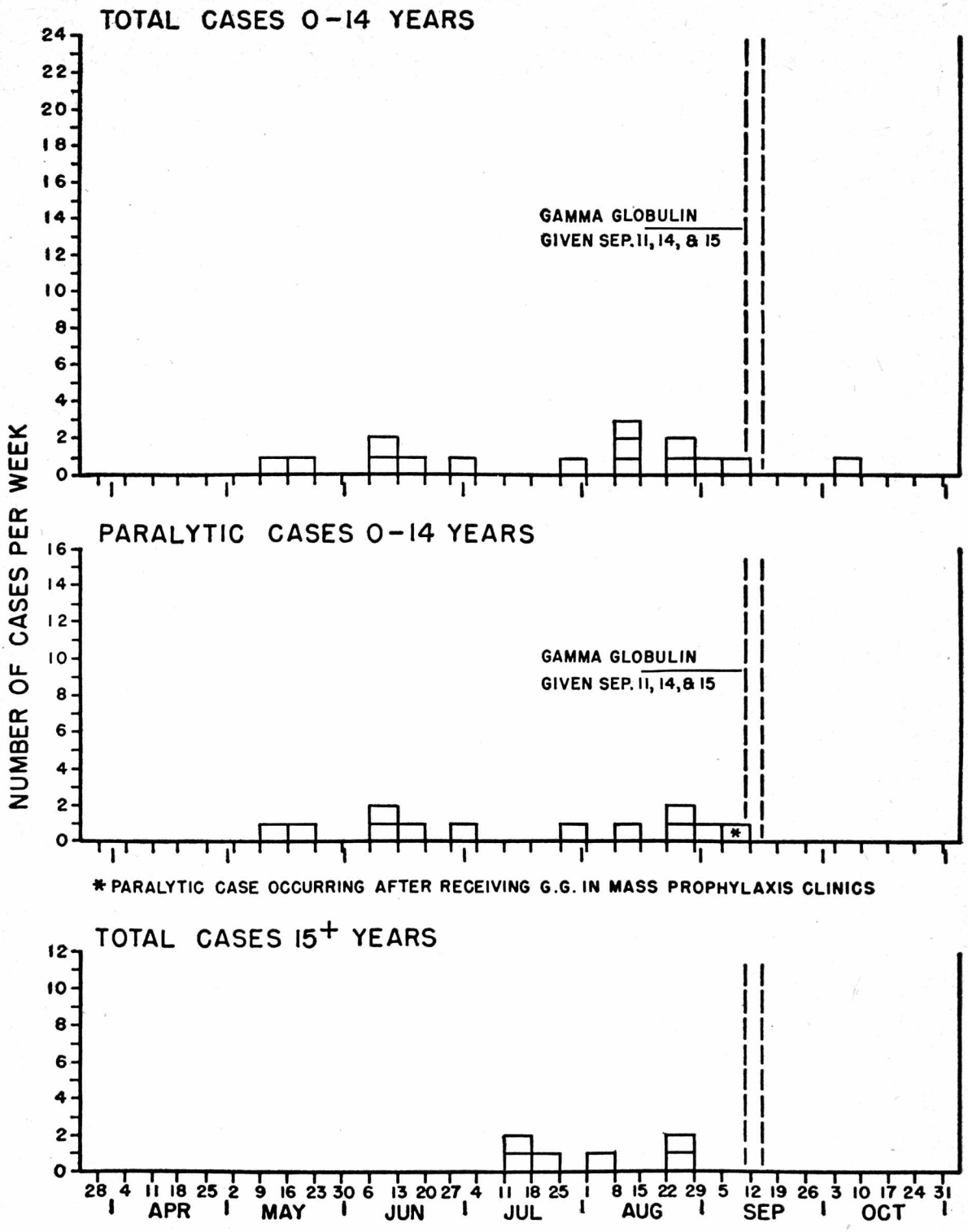


Figure 2B. Number of poliomyelitis cases per week, Benton County, Minn., 1953, by week of onset, age group, and paralytic status.





294578—54——12

Figure 3A. Total weekly poliomyelitis incidence rates per 100,000 population, Meeker County, Minn., 1953, by week of report, and paralytic status of cases, by week of onset.

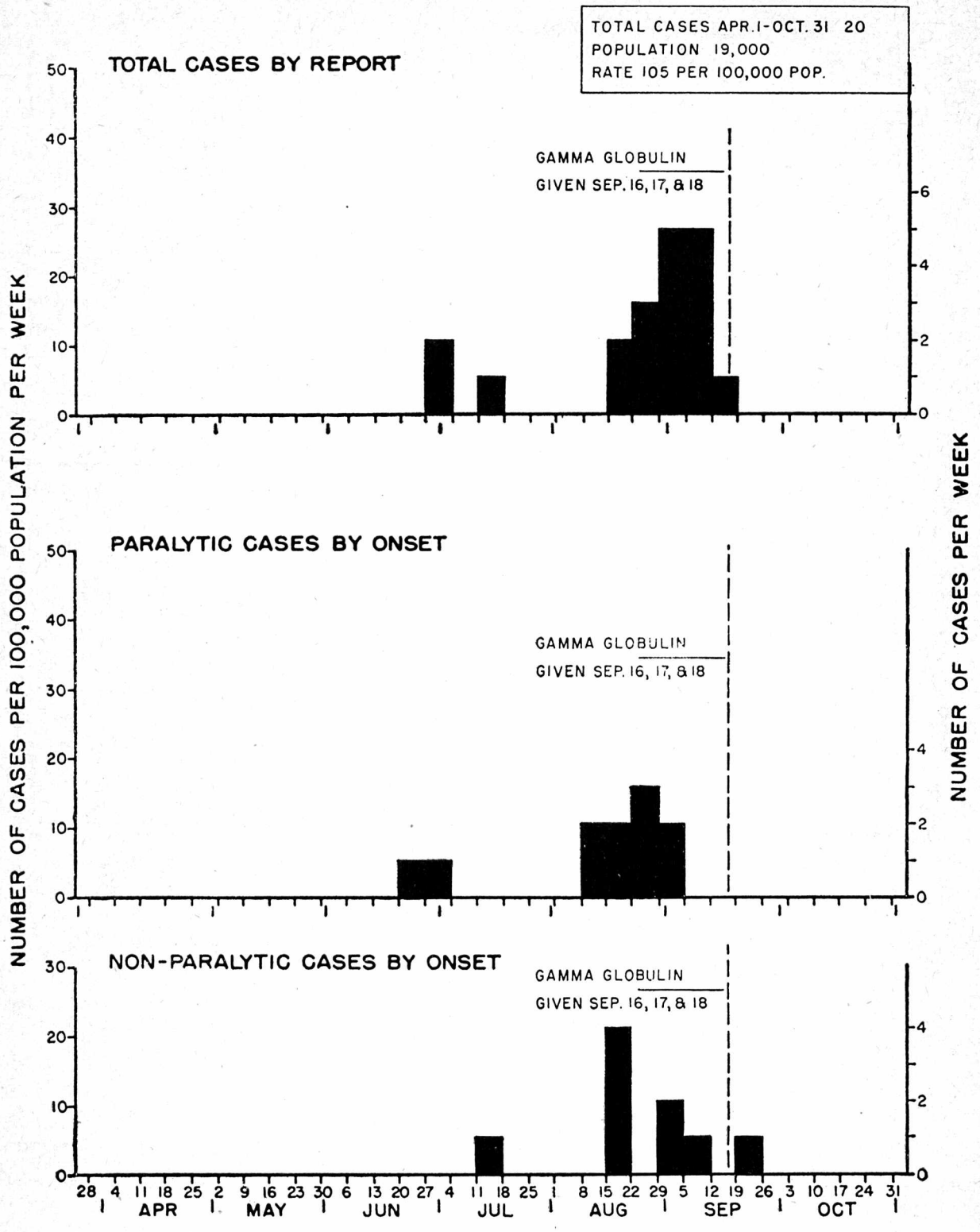
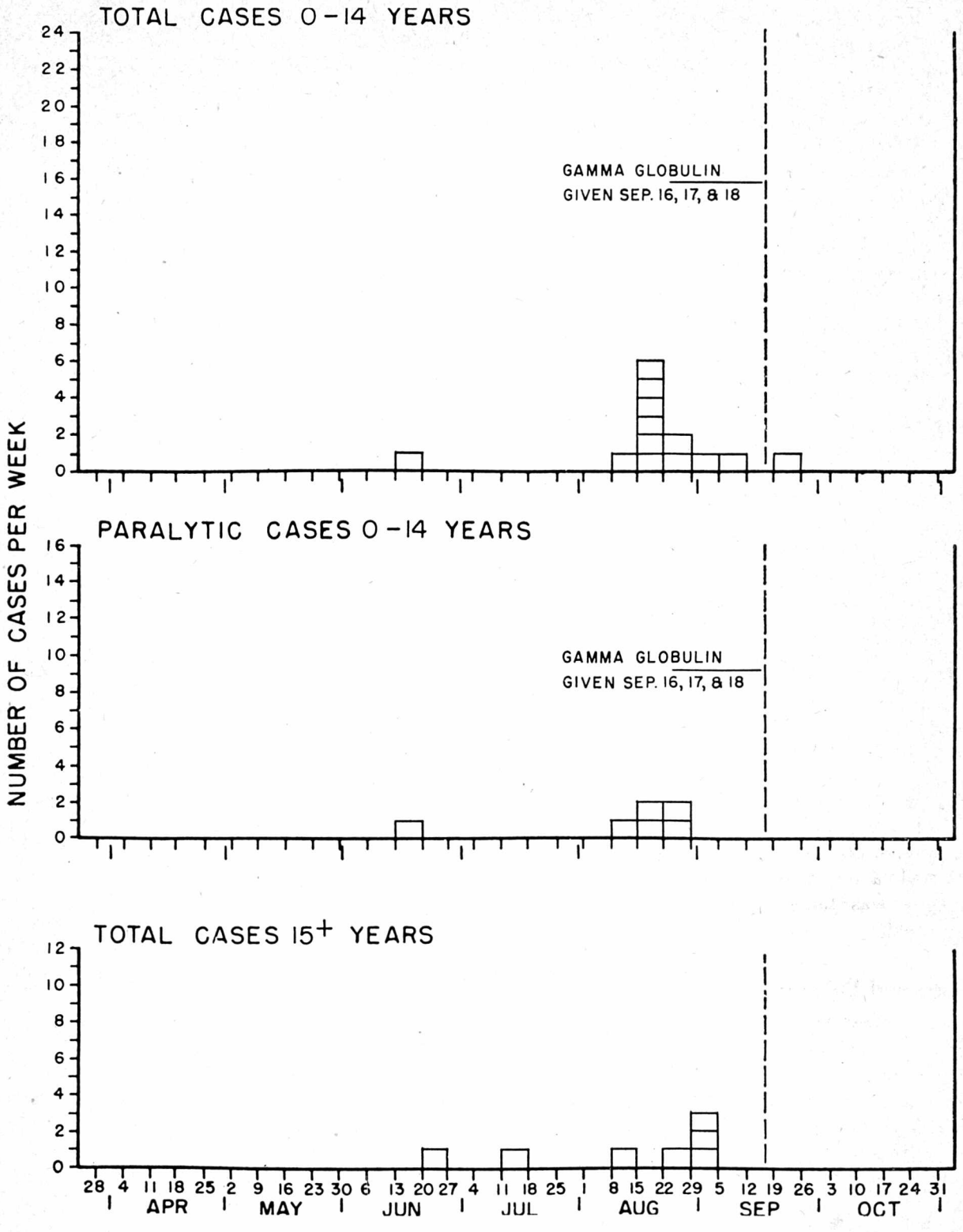


Figure 3B. Number of poliomyelitis cases per week, Meeker County, Minn., 1953, by week of onset, age group, and paralytic status.



# Monroe County, Florida

On September 21, 1953, Dr. R. J. Dalton, county health officer, Monroe County, Fla., called Dr. William Walter, associate director, bureau of preventable diseases, Florida State Board of Health, to inquire about the possibility of mass gamma globulin immunization for Monroe County. A visit was made to Monroe County on September 22, 1953, by Dr. Walter and Dr. Carl Bernet, Epidemic Intelligence Service officer, assigned to the Florida State Board of Health.

Between January 1 and September 22, 1953, a total of 31 cases had been reported, giving an attack rate of 104 per 100,000 population. Only 7 of the 31 patients, a total of 22.6 percent, were reported as paralytic. There had been two deaths, a case fatality rate of 6.5 percent. Thirty of the 31 cases had been hospitalized. Adult patients under the jurisdiction of the Navy had been hospitalized at the United States Navy Hospital in Key West. All the children and civilian patients were sent to the Variety Children's Hospital in Miami.

A preliminary review of the cases revealed an unusual pattern. In the first place, only 10 patients were under 7 years of age, while the remainder were between 19 and 30 years. Secondly, of the seven paralytic cases, four were children and three were adults. Because of the large group of nonparalytic adults, it was thought possible that two diseases were present simultaneously in the community. However, when detailed muscle evaluations were performed, a much higher incidence of paralytic disease was found than had been originally reported.

## Area and Poliomyelitis History

Key West is an island, 12 square miles in area, located at the southern tip of Florida, approximately 100 miles from the mainland. It is connected to the mainland by an overseas highway, over which all food and other supplies are usually brought. There are no livestock on the island. There are few flies, and only transient birds. Tourist trade and fishing are the principal civilian occupations. The population, according to the 1950 census, was 29,957, of which 3,200, or 10.7 percent, were nonwhite. There had been a 105-percent increase over the 1940 population. Ninety percent of the population reside in Key West proper. The remaining 10 percent are scattered along the Keys to the mainland. Although no exact figures are available, it is estimated that 50 percent of the population consist of naval personnel and their dependents.

The only other outbreak of poliomyelitis since 1940 occurred in 1946, when 43 cases were reported. That year 35 cases occurred between June 1 and July 15, with a peak in the second week of June. Fifty percent of the patients were over 15 years of age; no shift toward the older age group was noted as the epidemic progressed.

**Table 1. Total reported cases of poliomyelitis, Monroe County, Fla., 1940–52**

| *Year* | *Reported cases of poliomyelitis (paralytic and nonparalytic)* |
|---|---|
| 1940 | 0 |
| 1941 | 1 |
| 1942 | 1 |
| 1943 | 0 |
| 1944 | 2 |
| 1945 | 0 |
| 1946 | 43 |
| 1947 | 0 |
| 1948 | 2 |
| 1949 | 11 |
| 1950 | 6 |
| 1951 | 2 |
| 1952 | 14 |
| 1953 | 55 |

The annual number of reported cases of poliomyelitis since 1940 is presented in table 1.

## Reporting and Diagnosis

Cases were reported by telephone to the county health officer after a diagnosis was established. The call was made either by the private physician, or the base sanitation officer at the Naval Hospital. The name, address, race, sex, age, date of onset, and type of involvement were recorded. Usually suspected

nonparalytic cases were not reported unless a positive spinal fluid examination had been obtained. A county health nurse visited the household of every reported case to secure data concerning other members of the family. In addition, a Navy nurse visited the homes of naval personnel.

## Administration of Gamma Globulin

Gamma globulin was available to household contacts under the age of 30 and to pregnant women, regardless of age. In addition, it was frequently given to the playmates of younger children. Contacts of the naval personnel were given gamma globulin at the Naval Hospital. Civilians were injected by their private physician or by the county health officer at the discretion of the family physician.

On September 28, 1953, the county was authorized to conduct a mass prophylaxis program. Clinics were held on October 1 and 2, in Key West, and on October 5, for the rest of the Keys. Children who were unable to come to the clinics because of illness were inoculated at the Naval Hospital on October 3. A total of 8,550 injections were given.

## Epidemiologic Investigation

A household visit was made to every case of poliomyelitis, or a personal interview was conducted at the hospital. Information to complete PHS Form 400–88A (appendix D) was collected and a muscle evaluation was performed whenever feasible to determine the presence and extent of paralysis. The hospital record of all patients was reviewed. A case was considered "suspect" if there was no paralysis and no spinal puncture had been performed, or less than 10 cells had been found in the spinal fluid.

From January 1 to November 20, a total of 63 cases had been reported. Six of these patients were "suspect" cases and were excluded from the analysis. In two other patients, the diagnosis of poliomyelitis was changed, one to "hysteria" and one to "meningitis."

Of the remaining 55 cases, 27, or 49 percent, were paralytic. There was a total of 5 deaths representing 9.1 percent of the 55 cases. The promptness with which the patients were seen was reflected perhaps in the high spinal fluid cell counts which averaged 240 per cu. mm.

### *Distribution of Cases in Time*

Three cases occurred during the first 7 months of the year. The remaining 52 cases occurred in August, September, and October.

Following the case reported in July, no further poliomyelitis patients were reported for 19 days, and then three cases occurred on the same day. During the month of August, a few cases occurred each week, but in September, a rise in the weekly number of poliomyelitis patients was noted, the peak being reached during the middle of October. After October 16, only three cases were reported (table 2).

The incidence of paralysis closely paralleled the total number of cases throughout the epidemic.

### *Distribution of Cases by Age, Race, Sex, and Area of Residence*

The age- and race-specific attack rates are presented in table 3. All 55 cases occurred among the white race, giving an attack rate of

**Table 2. Distribution of total cases and paralytic cases of poliomyelitis, by week of report and week of onset, Monroe County, Fla., 1953**

| Week | Week of report [1] | | Week of onset [1] | |
|---|---|---|---|---|
| | Total cases | Number paralytic cases | Total cases | Number paralytic cases |
| July 11–17 | 1 | 0 | 1 | 0 |
| July 18–24 | 0 | 0 | 0 | 0 |
| July 25–31 | 0 | 0 | 0 | 0 |
| Aug. 1–7 | 3 | 1 | 3 | 1 |
| Aug. 8–14 | 2 | 1 | 2 | 1 |
| Aug. 15–21 | 0 | 0 | 1 | 1 |
| Aug. 22–28 | 2 | 1 | 2 | 1 |
| Aug. 29–Sept. 4 | 2 | 0 | 3 | 1 |
| Sept. 5–11 | 5 | 1 | 7 | 1 |
| Sept. 12–18 | 6 | 4 | 7 | 3 |
| Sept. 19–25 | 5 | 1 | 2 | 2 |
| Sept. 26–Oct. 2 | 6 | 4 | 5 | 3 |
| Oct. 3–9 | 4 | 3 | 7 | 3 |
| Oct. 10–16 | 12 | 5 | 10 | 5 |
| Oct. 17–23 | 2 | 1 | 0 | 0 |
| Oct. 24–30 | 2 | 2 | 3 | 3 |
| Oct. 31–Nov. 6 | 1 | 1 | 0 | 0 |
| Nov. 7–13 | 0 | 0 | 0 | 0 |
| Nov. 14–20 | 0 | 0 | 0 | 0 |
| Total | 53 | 25 | 53 | 25 |

[1] Two cases, both paralytic, occurred prior to April 1.

Figure 1A. Total weekly poliomyelitis incidence rates per 100,000 population, Monroe County, Fla., 1953, by week of report, and paralytic status of cases, by week of onset.

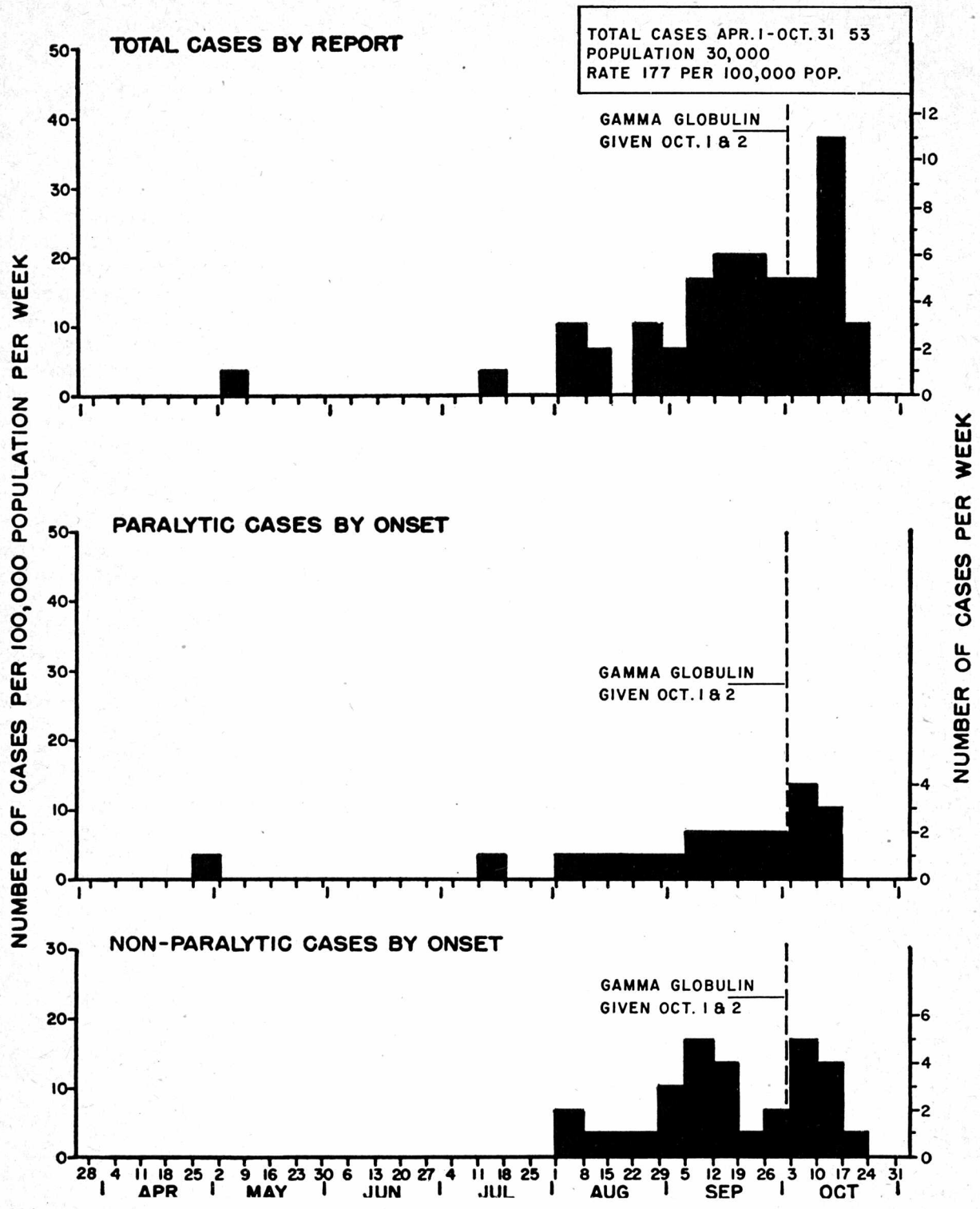
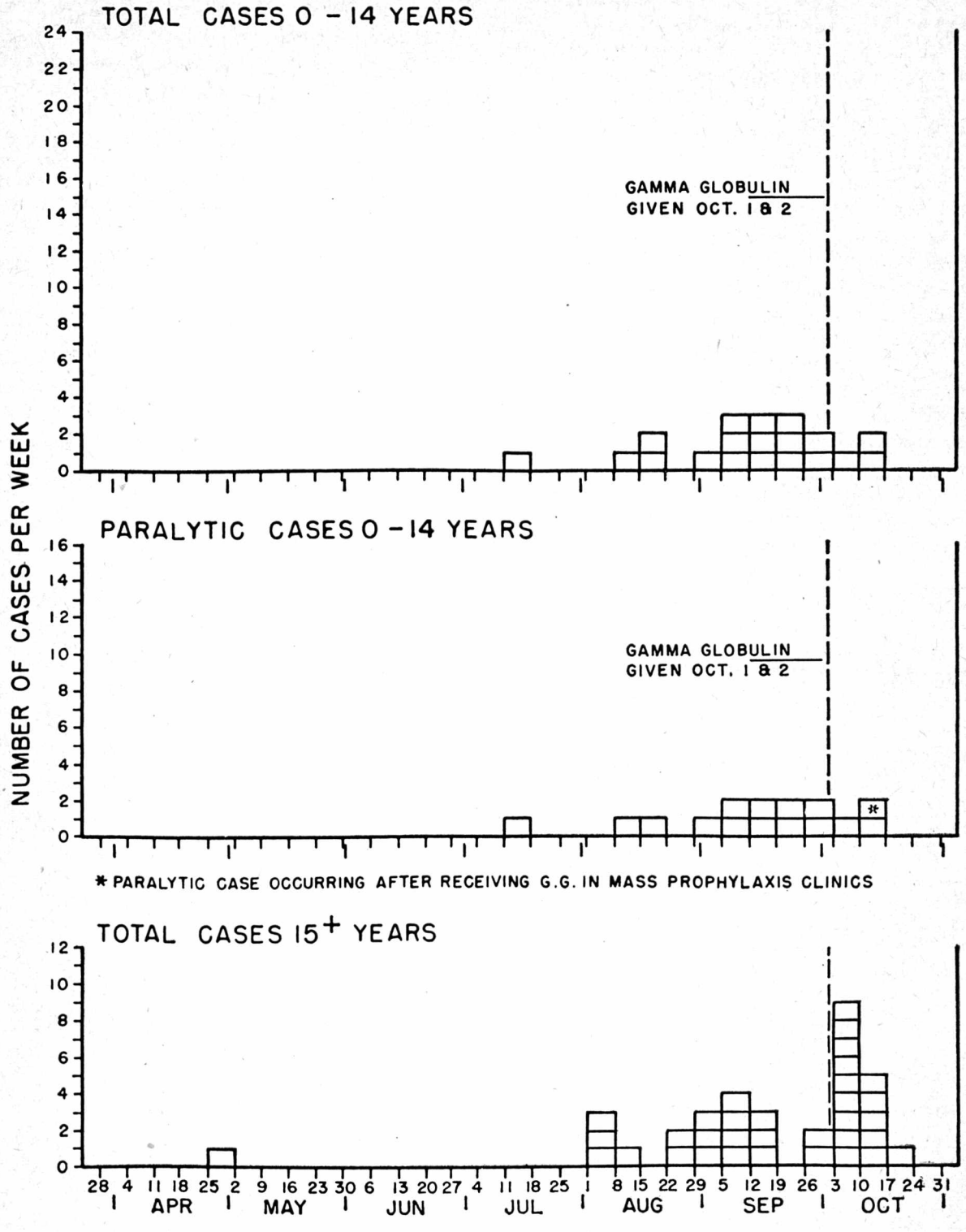


Figure 1B. Number of poliomyelitis cases per week, Monroe County, Fla., 1953, by week of onset, age group, and paralytic status.



206 per 100,000 population. The attack rates were highest in the 1–4 year age group, and in adults aged 25 to 29. Approximately 90 percent of the former patients were paralytic compared to only 40 percent of the latter. The paralytic rate was low between the ages of 10 and 24, while total attack rates were low between 10 and 19. It is interesting to note that only one person between the ages of 6 and 19 years became ill with poliomyelitis.

A total of 31 males and 24 females was reported, giving attack rates 176 and 198 per 100,000 population, respectively. All cases occurred in the city of Key West, with no cases being identified in the rest of the county.

Two of several housing projects in the area had 10 or more cases each, but population figures are not available. One of these projects consists predominately of officers and their families· the other is assigned to enlisted men.

*Familial Aggregation*

Two multiple-case households were identified, consisting of two cases each (tables 4 and 5). All 4 patients were nonparalytic adults. In one family, the husband and wife became ill concurrently. In the other, the husband was stricken 7 days after his wife.

*Cases Since Gamma Globulin Administration*

On October 1 and 2, gamma globulin was given to all the children under 15 and to all pregnant women in Key West. Prior to this date, 34 cases of poliomyelitis had occurred. Fourteen, or 41 percent, of these cases were under 15 years of age. After the mass inoculation program, 21 cases had their onsets. Four of these patients, or 19 percent, were under 15 years of age and three of them had not received gamma globulin. One pregnant woman,

**Table 3A. Number of paralytic and total cases of poliomyelitis, by age and race,[1] Monroe County, Fla., 1953**

| Age | 1950 population | | | Paralytic cases | | Total cases | |
|---|---|---|---|---|---|---|---|
| | White | Nonwhite | Total | White | Total | White | Total |
| <1 year | 610 | 61 | 671 | 1 | 1 | 2 | 2 |
| 1–4 years | 2, 421 | 309 | 2, 730 | 11 | 11 | 12 | 12 |
| 5–9 years | 1, 655 | 278 | 1, 933 | 3 | 3 | 4 | 4 |
| 10–14 years | 1, 166 | 255 | 1, 421 | 0 | 0 | 1 | 1 |
| 15–19 years | 2, 446 | 217 | 2, 663 | 1 | 1 | 2 | 2 |
| 20–24 years | 4, 433 | 348 | 4, 781 | 1 | 1 | 10 | 10 |
| 25–29 years | 3, 705 | 324 | 4, 029 | 8 | 8 | 20 | 20 |
| 30–39 years | 4, 328 | 487 | 4, 815 | 2 | 2 | 4 | 4 |
| All ages | 26, 736 | 3, 221 | 29, 957 | 27 | 27 | 55 | 55 |

[1] No cases among nonwhite population.

**Table 3B. Age-specific attack rates, by race,[1] cases per 100,000 population, Monroe County, Fla., 1953**

| Age | Paralytic cases | | Total cases | |
|---|---|---|---|---|
| | White | Total | White | Total |
| <1 year | 164 | 149 | 328 | 298 |
| 1–4 years | 455 | 404 | 495 | 440 |
| 5–9 years | 183 | 154 | 242 | 209 |
| 10–14 years | 0 | 0 | 85 | 70 |
| 15–19 years | 40. 7 | 37. 5 | 82 | 75 |
| 20–24 years | 22. 6 | 20. 9 | 226 | 209 |
| 25–29 years | 216 | 200 | 540 | 500 |
| 30–39 years | 46. 3 | 41. 5 | 92. 5 | 83 |
| All ages | 101 | 90 | 206 | 184 |

[1] No cases among nonwhite population.

**Table 4. Interval in days between onset of index cases and subsequent cases in multiple-case households, Monroe County, Fla., 1953**

| Interval (days) | Total cases | Paralytic cases |
|---|---|---|
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 2 | 0 | 0 |
| 3 | 0 | 0 |
| 4 | 0 | 0 |
| 5 | 0 | 0 |
| 6 | 0 | 0 |
| 7 | 1 | 0 |
| 8 | 0 | 0 |
| | 2 | 0 |

**Table 5. Summary of subsequent cases in multiple-case households, Monroe County, Fla., 1953** [1]

| Case No. | Household No. | Date of onset | Age | Interval from index case (days) | Diagnosis of paralysis |
|---|---|---|---|---|---|
| 5 | 1 | Aug. 4 | 22 | 0 | Nonparalytic. |
| 12 | 2 | Aug. 12 | 22 | 7 | Do. |

[1] Neither of the subsequent cases received gamma globulin.

who became ill 10 days after her injection, died of poliomyelits (table 6).

Of the 34 cases prior to the mass prophylaxis, 16, or 47 percent, were paralytic. Among the 21 cases after the gamma globulin program, 11, or 52 percent, were paralytic.

### *Followup Investigations*

It is planned to perform a standardized muscle evaluation 50–70 days after onset on all patients. In addition, blood and stool specimens are being examined at the Virus Laboratory of the Communicable Disease Center in Montgomery, Ala. No detailed information about the outcome of these studies is available at this time.

**Table 6. Summary of all cases having onsets after the mass inoculation of gamma globulin on October 1 and 2, 1953, Monroe County, Fla.**

| Case No. | Age | Date of onset | Diagnosis of paralysis | Interval, gamma globulin to onset (days) |
|---|---|---|---|---|
| | A. Those receiving gamma globulin | | | |
| 45 | 26 | Oct. 10 | [1] P | 10 |
| 53 | 1 | Oct. 15 | P | 13 |
| | B. Those not receiving gamma globulin. | | | |
| 34 | 26 | Oct. 5 | P | |
| 35 | 30 | Oct. 1 | NP | |
| 37 | 25 | Oct. 4 | NP | |
| 39 | 28 | Oct. 6 | P | |
| 40 | 27 | Oct. 4 | NP | |
| 41 | 24 | Oct. 10 | NP | |
| 42 | 21 | Oct. 5 | NP | |
| 43 | 34 | Oct. 9 | NP | |
| 44 | 24 | Oct. 6 | P | |
| 46 | 29 | Oct. 12 | P | |
| 47 | 37 | Oct. 10 | P | |
| 48 | 24 | Oct. 11 | NP | |
| 49 | 29 | Oct. 12 | NP | |
| 50 | 28 | Oct. 13 | NP | |
| 51 | 4 | Oct. 13 | P | |
| 52 | 28 | Oct. 12 | NP | |
| 54 | 2 | Oct. 24 | P | |
| 55 | 1 | Oct. 24 | P | |
| 56 | 28 | Oct. 30 | P | |

[1] Patient expired.
P=paralyzed; NP=not paralyzed.

## Summary

An outbreak of poliomyelitis in Monroe County, Fla., is described. The epidemic was unusual in that a large number of adult cases occurred. Gamma globulin mass prophylaxis was given, but no firm conclusions as to its efficacy can be drawn from these data at this time.

*Appendix C*

# The Abridged System of Muscle Evaluation Used In the Gamma Globulin Evaluation Program

The evaluation of an agent producing modification of severity of paralysis requires a consistent and practical method of measuring the severity of the disease. Furthermore, in the present study the method had to be applicable for general field use throughout the country both in the clinic and in the home.

The abridged system employed in this study was specially developed by Dr. Jessie Wright. It was abbreviated and revised from the more elaborate system used in the gamma globulin field trials of 1951 and 1952. Using the capacity to move against gravity and manual resistance as criteria of muscle strength, individual muscles or muscle groups are graded into six categories: normal, good, fair, poor, trace, and no power. No intermediate grades are employed. Each category is given a numerical grade ranging from 0 for normal to 5 for no power. In addition, each muscle, or group of muscles, is assigned a factor, proportional to its bulk, using the tibialis anticus as a standard with a factor of 1. The various factors for other muscles range from 0.25 (such as the interossei) to 4 (the quadriceps femoris).

To obtain a score for each muscle, the bulk factor is multiplied by the numerical grade, and the scores for all muscles are then added to provide a total score. The highest possible score, indicating 100-percent involvement, is 470. The ratio of the patient's score to this total represents the "percent involvement" (see accompanying standard form and scoring instructions).

The cranial nerve musculature is graded in a somewhat different manner, since it is not possible to determine accurately the degree to which such a muscle is involved. The method of cranial nerve scoring is outlined in the attached instruction sheet.

Since the muscle evaluation system used in this study differed in some respects from the methods with which physical therapists were most familiar, and since maximum uniformity was essential, three orientation sessions of several days' duration were held during July and August in three sections of the country for the physical therapists, Epidemic Intelligence Service officers, and nurse officer epidemiologists providing services in the participating States. The sessions took place at the D. T. Watson School of Physiatrics in Leetsdale Pa.; at the School of Physical Therapy, Northwestern University School of Medicine, Chicago; and at the Orthopedic Hospital in Los Angeles. The instructors were Miriam Jacobs, Mary Elizabeth Kolb, and Kathryn Kelley of the D. T. Watson School.

It was felt that a high degree of uniformity of results might be achieved through these orientation sessions. In order to provide some information about this point and about the general validity of the muscle evaluation system, a series of small-scale trial studies were performed by Dr. Abraham Lilienfeld, director of the Evaluation Center; Miriam Jacobs, of the D. T. Watson School; and Myron Willis, of the statistics section of the Communicable Disease Center.

Basically, these studies were concerned with the reproducibility of muscle evaluations as performed by different examiners. This problem was considered to be of prime importance since the evaluation of cases to be studied in the National Evaluation Program were to be performed by about 35 physical therapists. It was considered of further interest to determine whether the utilization of weighting factors in the computing of muscle scores would result in the introduction of certain biases.

The study of the variability of muscle evaluations between examiners was based on a series

**Figure 1. Standard muscle evaluation form.**

| % INVOLVEMENT | |
|---|---|
| TOTAL SCORE | |
| DIAGNOSIS | |

## MUSCLE EXAMINATION

NAME _____ (Last / First / Middle) I ☐ S ☐ BIRTHDATE _____

ADDRESS _____ (Street) INJECTION DATE _____

_____ (City / County / State) ONSET DATE _____

PARENT'S NAME _____ PHONE _____ MUSCLE EXAMINATION DATE _____

| LEFT | | | | RIGHT | | | LEFT | | | | RIGHT | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S | NV | G | | G | NV | S | S | NV | G | | G | NV | S |
| | | | **RESPIRATION** | | | | | | | 0.25 ***DEGLUTITION** 0.25 | | | |
| | | | 0.5 Diaphragm 0.5 | | | | | | | Degree 1 | | | |
| | | | 0.5 Intercostals 0.5 | | | | | | | Degree 2 | | | |
| | | | **VOICE** | | | | | | | Degree 3 | | | |
| | | | Nasal | | | | | | | 0.25 **TONGUE** 0.25 | | | |
| | | | 0.25 Hoarse 0.25 | | | | | | | Deviation | | | |
| | | | Syllabic Speech | | | | | | | Atrophy | | | |
| | | | Decreased Volume | | | | | | | 0.5 **MASTICATION** 0.5 | | | |
| | | | 0.5 **FACE** 0.5 | | | | | | | Deviation | | | |
| | | | Ocular | | | | | | | Lacks Firm Closure | | | |
| | | | Nasal | | | | | | | Atrophy | | | |
| | | | Oral | | | | | | | 0.25 **PALATE** 0.25 | | | |
| | | | **NECK** | | | | | | | **TRUNK** | | | |
| | | | 1 Anterior 1 | | | | | | | 3 Erector Spinae 3 | | | |
| | | | 1 Lateral 1 | | | | | | | 1 Anterior Abdominals 1 | | | |
| | | | **UPPER EXTREMITIES** | | | | | | | 2 Lateral Abdominals 2 | | | |
| | | | 1 Scapula Adductors 1 | | | | | | | **LOWER EXTREMITIES** | | | |
| | | | 1 Serratus Magnus 1 | | | | | | | 2 Gluteus Maximus 2 | | | |
| | | | 1 Pectoralis Major 1 | | | | | | | 1 Hip Flexors 1 | | | |
| | | | 2 Inward Rotators 2 | | | | | | | 1 Gluteus Medius 1 | | | |
| | | | 1 Outward Rotators 1 | | | | | | | 2 Hip Adductors 2 | | | |
| | | | 1 Deltoideus 1 | | | | | | | 4 Quadriceps 4 | | | |
| | | | 2 Elbow Flexors 2 | | | | | | | 2 Inner Hamstrings 2 | | | |
| | | | 1 Triceps 1 | | | | | | | 1 Outer Hamstring 1 | | | |
| | | | 1 Wrist Flexors 1 | | | | | | | 3 Gastrocnemius 3 | | | |
| | | | 1 Wrist Extensors 1 | | | | | | | 1 Tibialis Anticus 1 | | | |
| | | | 1 Finger Flexors 1 | | | | | | | 1 Tibialis Posticus 1 | | | |
| | | | 1 Finger Extensors 1 | | | | | | | 1 Peroneals 1 | | | |
| | | | 0.25 Opponens Pollicis 0.25 | | | | | | | 1 Toe Flexors 1 | | | |
| | | | 0.25 Thumb Abductors 0.25 | | | | | | | 1 Toe Extensors 1 | | | |
| | | | 0.25 Thumb Flexors 0.25 | | | | | | | | | | |
| | | | 0.25 Thumb Extensors 0.25 | | | | | | | | | | |
| | | | TOTAL SCORE | | | | | | | TOTAL SCORE | | | |

EXAMINER:

| N or 100% NORMAL | G or 75% GOOD | F or 50% FAIR | P or 25% POOR | T or 10% TRACE | N.P. or O NO POWER | †, ††, ††† Spasm according to severity |
|---|---|---|---|---|---|---|
| Function against gravity and resistance | Function against gravity and some resistance | Function against gravity only | Function in horizontal plane | A few fibers have active function | | |

Respiration, Voice, Face, Deglutition, Tongue, Mastication and Palate checked ( √ ) to show involvement Qualitative grade not attempted.

* Degree 1—Accumulation of secretions present; patient able to clear throat and swallow without help.
Degree 2—Excess amount of secretions but area can be cleared by suctioning.
Degree 3—Area fills rapidly; suctioning not sufficient and tracheotomy necessary.

Highest Score Possible 470

**Scoring Instructions for Standard Muscle Evaluation Form.**

1. Note letter grades N, G, F, P, T, O in the column marked "G."

2. Transpose letter grades to numerical values in column marked "NV." Code as follows:

| Grade | *Numerical value* |
|---|---|
| N | 0 |
| G | 1 |
| F | 2 |
| P | 3 |
| T | 4 |
| O | 5 |

3. In the columns where there is a check (√) and not a letter grade, indicate the following numerical values in the column marked "NV."

*Respiration*
Diaphragm (√) −3
Intercostals (√) −3

*Voice*
Hoarse (√) −3

*Face*
Ocular (√)
Nasal (√)
Oral (√)
If one of the above is checked place *1* opposite *Face* in "NV" column.
If 2 of the above are checked place *2* opposite *Face* in "NV" column.
If 3 of the above are checked place *3* opposite *Face* in "NV" column.

*Deglutition*
Degree 1 (√) − 1 opposite *Deglutition* in "NV" column.
Degree 2 (√) − 2 opposite *Deglutition* in "NV" column.
Degree 3 (√) − 3 opposite *Deglutition* in "NV" column.

*Tongue*
Deviation (√).
Atrophy (√).
If any of the above are checked place *3* opposite *Tongue* in "NV" column.

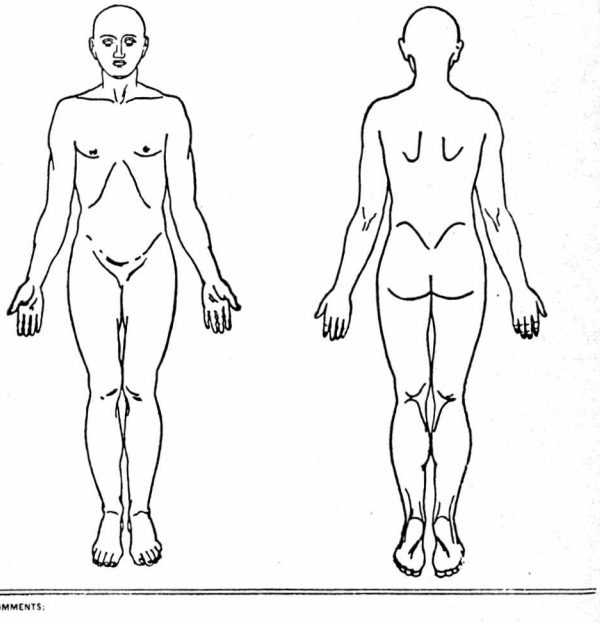
*Mastication*
Deviation (√)
Lacks firm closure (√)
Atrophy (√)
If any of the above are checked place *3* opposite *Mastication* in "NV" column.

*Palate* (√) − 3

4. Multiply the numerical value by the factor rating (listed on either side of the muscle) and place this score in the column marked "S."

5. Total all columns marked "S" and place the grand total in space provided in box at top of muscle examination form.

6. Calculate percent involvement and place in space provided in box at top of muscle examination form. To obtain percent involvement: Divide the total score by 470.




**Reverse of figure 1, greatly reduced.**

of four separate trials in which a number of patients were each evaluated by two or more examiners. The results might be summarized as follows:

1. There exists a rather high degree of consistency in the determination of percent muscle bulk involvement. In general, the average difference between examiners was approximately 3 percent.

2. When a direct comparison was made of the frequency with which two examiners agreed in the actual grading of a muscle, it was shown that they agreed completely about 70 percent of the time, and within plus or minus one grade 90 percent of the time.

3. It could be shown that most of the disagreement between the examiners existed primarily in the differentiation of a normal from a good muscle. When normal and good muscles are grouped together as one grade, the degree of consistency achieved rose to approximately 90 percent. This grouping has the disadvantage, however, of diminishing the sensitivity of the examination.

4. Finally, the muscle score, the percentage of muscles not normal, and the percent of muscles not normal or good for a group of patients were computed and compared with each other. It was noted that the relationship between the muscle scores and the other two indices of severity was rather good. This would indicate that the use of weighting factors does not result in the introduction of biases, as had been feared.

In summary, these studies show that, under ideal circumstances, the consistency of results obtained by different observers is surprisingly great, and that the results obtained by the large group of physical therapists would be of a sufficient degree of uniformity to be additive.

A more detailed report of these studies entitled: "A Study of Certain Aspects of the Method of Muscle Evaluation Used in the Gamma Globulin Evaluation Program 1953," by A. M. Lilienfeld, M. Jacobs, and M. Willis has been prepared and will be published in a scientific journal.

*Appendix D*

# Multiple-Case Household Investigation Form Used In National Gamma Globulin Evaluation Program

PHS 400.88A (CDC) GA.
6-53

DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
Public Health Service
Communicable Disease Center

FORM APPROVED
BUDGET BUREAU NO. 68-R518

NATIONAL PROGRAM FOR EVALUATION OF GAMMA GLOBULIN IN POLIOMYELITIS

CASE INVESTIGATION FORM
(Multiple Case Households)

Local Household Number _____ Case No. _____

State City County

For Evaluation Center Use
Type of Case: Index 1 ☐ Subsequent 2 ☐ Prior 3 ☐

1. Name of Household Head

2. Phone Number

| 3. Name of Patient | 4. Date of Birth Mo Day Yr | 5. Age | 6. Sex | 7. Color or Race |
|---|---|---|---|---|
| | | | | |

8. Home Address

9. Reporting Physician, Name, Address

10. Name of Informant and Relationship to Patient

11. Date of Onset: Mo Day Yr

| 12. Gamma Globulin Administered: Yes 1 ☐ No 2 ☐ | Date Injected Mo Day Yr | Amount, if known cc | Site of Injection: Rt. Buttock 1 ☐ Lft. Buttock 2 ☐ Specify Other: |
|---|---|---|---|
| | | | |

| 13. History within month preceding onset of: | Type | Site | Mo | Day |
|---|---|---|---|---|
| (a) All throat & mouth operations | | | | |
| (b) All injections | | | | |

14. If female – date of last menstrual period: Mo Day Yr If pregnant, Trimester:

15. Verified Diagnosis, 7–14 days after onset:
Not Polio 1 ☐
If Polio, paralytic 2 ☐ non-paralytic 3 ☐ suspect 4 ☐
If Paralytic, check muscle areas involved: Bulbar 1 ☐ Rt. Arm 2 ☐ Lft. Arm 3 ☐ Trunk 4 ☐ Rt. Leg 5 ☐ Lft. Leg 6 ☐
Severity
Exam. Date: Mo Day

Source of diagnosis: Hosp. Record 1 ☐ Private Physician 2 ☐ Personal Examination 3 ☐

16. Hospital Yes 1 ☐ No 2 ☐

| Hospital Name and Address | Hospital Record No. | | Mo | Day | Yr |
|---|---|---|---|---|---|
| 1. | | Adm | | | |
| | | Disch | | | |
| 2. | | Adm | | | |
| | | Disch | | | |

| 17. Spinal Fluid: Yes 1 ☐ No 2 ☐ | Date Mo Day | Cells | Total Protein |
|---|---|---|---|
| | | | |

18. Muscle Evaluation, 50–70 days after onset:
No Paralysis 1 ☐
Paralysis Present 2 ☐
If Paralysis present, check muscle areas involved: Bulbar 1 ☐ Rt. Arm 2 ☐ Lft. Arm 3 ☐ Trunk 4 ☐ Rt. Leg 5 ☐ Lft. Leg 6 ☐
Severity
Exam. Date: Mo Day
Name of Physical Therapist:

19. Death of Patient: Yes 1 ☐ No 2 ☐ Date: Mo Day Yr

20. Names of other cases in household

| | Date of Onset Mo | Day |
|---|---|---|
| | | |
| | | |

21. Name of Investigator Date:

INSTRUCTIONS FOR CASE INVESTIGATION FORM
(Items not discussed in instructions are self-explanatory)

General: This form is to be filled out on all cases in household with 2 or more cases. Entry for local household number and case number within a household are provided so that all case forms for a given household may be stapled together for submission to the National Evaluation Center. The case number may be entered in chronological order of receipt of reports, 1,2, etc. From information on the forms, determination will be made by the NEC as to whether a given case is the index, subsequent or prior case.

1. Name of Household Head: Enter last name, first name and initial.
Definition of household: a household includes all persons who occupy a house, an apartment or other group of rooms, or a room that constitutes a dwelling unit. In general, a group of rooms occupied as separate living quarters is a dwelling unit if it has separate cooking equipment or a separate entrance. A household includes the related family members and also unrelated persons, if any, such as lodgers, foster children, wards or employees, who share the dwelling unit. Regularly employed servants, including those who work during the day and do not sleep in the house are considered household members.

5. Age of Patient: age at last birthday; if under 1 year, specify months, e.g., 6 mo.

7. Color or Race: in areas where classification is made on basis of white and non-white, enter W or NonW; in other areas where designation is made on basis of race, enter White, Negro, Indian, etc.

8. Home Address: complete street address, apartment number; if rural, road and RFD route.

9. Reporting Physician: the physician attending case who reported case to health department. Give name and street address; include city and state if different from that of patient.

10. Name of informant and relationship to patient: name of person furnishing information for Case Investigation Form. If not related, specify if informant is lodger, neighbor, servant, etc.

11. Date of Onset: defined as the date of onset of any continuous illness leading to the signs and symptoms of central nervous involvement which is subsequently diagnosed as poliomyelitis.

13. History within month preceding onset of case, of:
(a) All throat and mouth operations which includes tonsillectomies, adenoidectomies, tooth extractions, irradiation therapy of adenoids, etc.
(b) All injections which includes immunizations, skin tests, therapeutic injections, but excludes gamma globulin injection entered in Item 12.

14. If female - of appropriate age - ascertain date of onset of last menstrual period. If pregnant, enter whether pregnancy is in first, second or third trimester.

15. Verified diagnosis, 7-14 days after onset: to be obtained from hospital, physician, or by personal examination. Check source if by personal examination. Enter date. Severity code to be transcribed from special form, if used.

16. Hospital: record all hospital admissions and discharges during course of illness.

17. Spinal fluid: if several examinations were made, enter examination with most positive findings. If all negative, enter results of one.

18. Muscle Evaluation, 50-70 days after onset: to be transcribed from physical therapist's record.

20. Names of other cases in household: enter names of other current case or cases and dates of onset.

21. Name of Investigator: give name and designation, such as health officer (HO), public health nurse (PHN), epidemiologist (EP), or communicable disease investigator (CDI); give date of investigation.

Copies of all records on each case in the household to be stapled together and forwarded to NATIONAL EVALUATION CENTER, COMMUNICABLE DISEASE CENTER, 50 SEVENTH ST., N. E., ATLANTA 5, GA. in accordance with outlined procedures.

*Appendix E*

# Antibody Content of Different Lots of Gamma Globulin

Two reports are available on the titration of antibody for the three types of poliomyelitis virus. One is by Youngner (*1*) and the other is a manuscript prepared for publication by Opton, Nagaki, and Melnick (*2*). Youngner's report deals with tests on six lots of gamma globulin used by Hammon and his associates in their field trials, and the report of Melnick and his associates deals with 65 lots of gamma globulin used in the United States in 1953. Unfortunately, the tests were done differently by the two groups of investigators, each using different amounts of virus and different amounts of gamma globulin. Thus, Youngner measured the effect of 0.25 ml. of gamma globulin against thirty-two 50-percent tissue culture doses ($TCD_{50}$) of virus, while Melnick and his associates tested the effect of 0.10 ml. of gamma globulin against 100 $TCD_{50}$. Neither group of investigators used a standard of reference in their tests to correct for variations which are known to occur in tests set up on different days. Nevertheless, the results of both groups present titers of Type 1 antibody which vary within approximately a fourfold range in one laboratory (Youngner—1:483 to 1:2,048) and as much as a tenfold range (1:160 to 1:2,000) in the other laboratory.

In the absence of data based on a correction with reference to a standard used in each test, there is not much point in determining the proportion of preparations with high titers and with low titers. A threefold difference in titer may represent a very important difference in the results obtained with preparations containing such borderline quantities of antibody. Thus, gamma globulin having a titer of 1:600 may be worthless in the dosage used (0.14 ml. per lb. body weight) after dilution in the body, while a preparation with a titer of 1:2,000 may just supply a minimally detectable amount of antibody in the blood stream of inoculated individuals. It should be stressed here that unfortunately no data are as yet available on actual tests for the presence and persistence of antibody in the blood of individuals inoculated with preparations of known potency determined by a suitable standard method of assay.

In view of all this, the significant fact appears to be that, in a single test on different preparations of gamma globulin, variations of the order of threefold to fivefold have been observed. Since the tests performed in the Pittsburgh laboratory are more sensitive than those performed in the New Haven laboratory, it would appear that the potency of different lots of gamma globulin used by Hammon and his associates in their field trials was not greater than those used in the United States in 1953. This does not mean to say that the potency of gamma globulin used in any one place might not have varied within a threefold to fivefold range, and that therefore a serious deficiency of this study was the lack of knowledge concerning the antibody content of the various lots of gamma globulin used in each particular area this year.

REFERENCES

(*1*) Youngner, J. S.: Poliomyelitis virus antibody in different lots of human serum gamma globulin. Proc. Soc. Exper. Biol. & Med. 84: 697–699 (1953).

(*2*) Opton, E. M., Nagaki, D., and Melnick, J.: Poliomyelitis antibodies in human gamma globulin. Unpublished.

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